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VOLUME 14, NO. 8
AUGUST 1982

THE SHOCK AND VIBRATION DIGEST

A PUBLICATION OF
THE SHOCK AND VIBRATION
INFORMATION CENTER
NAVAL RESEARCH LABORATORY
WASHINGTON, D.C.

OFFICE OF
THE UNDER
SECRETARY
OF DEFENSE
FOR RESEARCH
AND
ENGINEERING

A publication of

THE SHOCK AND VIBRATION INFORMATION CENTER

Code 5804, Naval Research Laboratory
Washington, D.C. 20375

THE SHOCK AND VIBRATION DIGEST

Volume 14, No. 8
August 1982

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Dr. R.L. Eshleman
Vibration Institute
Suite 206
101 West 55th Street
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SVIC NOTES

SOFTWARE AND HARDWARE DEVELOPMENTS IN THE ENVIRONMENTAL TEST LAB

The Environmental Test Lab has become more and more computer oriented. When digital control first hit the labs there were only two or three companies selling the equipment. There was little flexibility built into some of the machines. They would run the standard environmental tests such as swept sine or random, but with some equipment you couldn't modify the programming code.

Today the situation is different. Most vendors of environmental test equipment supply open code with their equipment. By open code I mean you can print out a copy of the program and make modifications to it if you wish. This has come about in response to user needs and I think it is a healthy trend.

However, the environmental testing is becoming more and more sophisticated. We are today running such things as Combined Environments Reliability Test (CERT), random with discrete swept sine components superimposed and multi point random inputs. This degree of sophistication has also made it more important for users to be able to write and modify their code. Another trend is towards modularization. It is today possible to buy hardware modules from various vendors and put together your own system. You can even buy the software for post-processing the data into charts and graphs etc.

One interesting hardware development is the use of CAMAC interfacing equipment in the environmental test lab. CAMAC interfacing equipment was developed many years ago at CERN in Geneva, Switzerland for use in running high energy physics experiments. Basically it is a very flexible interfacing module which allows the experimenter to interconnect a NIM (Nuclear Instrumentation Module) to a computer. With a CAMAC interface you don't have to design and build a new interconnecting module every time you want to interconnect a NIM module to a computer. These types of flexible, modularized systems are already being used in the test lab. One interesting feature is the ability to extract information on a particular environmental test from a graphics terminal in your own office. With a CAMAC interface this is an easy thing to do. It makes it easy for Program Managers to monitor a series of tests.

In the area of software development for environmental testing there really hasn't been much activity. One vendor does offer an ATS BASIC where ATS stands for Automatic Test Basic. Perhaps it would be better to take a fresh start and develop a special language from scratch. If this is done it would probably be good to have a single industry standard such as was developed for the Automatic Test Equipment (ATE) community. The ATE community uses ATLAS (Abbreviated Test Language for All Systems).

ATLAS is maintained as IEEE Std 416-1981. It is a standard language for expressing test specifications and test procedures. It is a test-oriented language independent of test equipment, and provides a standard abbreviated English language used in the preparation and documentation of test procedures which can be implemented either manually or with semi-automatic equipment.

You can't use ATLAS directly as a computer program; you use ATLAS to unambiguously specify a test. To run a test, the ATLAS specifications are run through an ATLAS compiler to create an actual computer code.

ATLAS in its present form is probably too flexible for use in an environmental test lab, but something similar could be developed based on the principles used in ATLAS.

We at SVIC are always interested in relaying new developments to the shock and vibration community. If you know of any new software/hardware developments, please tell us about them and we will try to relay the information.

J.G.S.

EDITORS RATTLE SPACE

THE AMERICAN STANDARDS PROGRAM

During the month of May the United States Supreme Court released an opinion in the case of Hydrolevel vs ASME. The Court affirmed an earlier decision by the Court of Appeals for the Second Circuit that ASME is liable for anticompetitive acts against Hydrolevel Corporation by two volunteer members of a standards committee. Because the U.S. standards program is dependent upon volunteers, most of whom work for non-for-profit societies and associations, the decision will affect voluntary standards efforts in the U.S. for years to come.

The lawsuit has been a long and costly one for ASME. Because of the implications of this legal opinion on future standards activity, I feel that the ASME was correct in vigorously pursuing the case.

In effect the Court's decision held ASME liable for damages on the interpretation of a legal standard prepared by its volunteer members. The case began in 1975 when Hydrolevel Corporation charged that two volunteer members of ASME had conspired to misinterpret a section of the Society's Boiler and Pressure Vessel Code. Hydrolevel claimed that its attempt to market a "probe" type low-water fuel cutoff for boilers was impaired. Subsequently the U.S. District Court for the Eastern District of New York found ASME guilty of participating in a conspiracy to restrain trade under the Sherman Anti-Trust Act.

How does one balance a charge of restraint of trade against the many lives that have been saved as a result of restrictions stated in the boiler code? Many corporations and engineers gave freely of their time and money to prepare and write this code in the public's interest. Without the talents of volunteers the code could not have been written and made available at any price. However, the public has in effect reprimanded the ASME for its activities through the ruling of the Supreme Court.

The possibility of restraint of trade exists in any standard; furthermore all public standards in the U.S. are generated by volunteer-type organizations. Thus the ongoing standards program in the U.S. faces difficult times. In the dissenting opinion, Associate Justice Lewis F. Powell called the opinion of the majority unprecedented. The dissenters concluded that there is no way in which an association can adequately protect itself from this sort of liability.

In effect the decision means that the U.S. standards program will be weakened because volunteers (individuals and companies) will not expose themselves to the potential liability of restraint of trade when in fact they receive no compensation for their efforts. In addition, associations and societies will now be forced to think very carefully about engaging in standards development. Those who decide to continue will add bureaucratic checks to assure nonliability to trade restraint, thereby slowing even more the already tedious process of standard preparation. In my opinion the public has lost on this issue of restraint of trade versus safety.

R.L.E.

A REVIEW OF STRUCTURAL NOISE TRANSMISSION

R.H. Lyon* and J.W. Slack**

Abstract. This article characterizes theoretical and experimental analyses of noise transmission in structures. The transmission path and vibratory response are discussed, as are the uses of broadband transfer functions to estimate time-varying response and of signal processing to diagnose vibration sources and paths.

The phenomena and effects that relate the dynamic loads and motions within a machine to the radiated sound from supporting structures can be classed as structural noise transmission, as can the transmission of vibrational noise energy within purely passive structures. The success or failure of a design from a noise point of view is dependent on how well structural transmission is dealt with. This review relates to theoretical and experimental analyses of noise transmission; such basic information has had relatively little influence on design procedures. Design methods tend to use rules of thumb or trade-off relations based on field data, laboratory experiments, and calculations. A major goal is to extend and strengthen the predictive aspects of the designer's work.

CHARACTERIZING THE SOURCE OF VIBRATION

A source of vibrational energy can be characterized as shown in Figure 1. The free velocity or blocked force generated by the machine, along with its internal impedance at the mounting points defines its ability to generate vibration in a supporting structure.

Consider the behavior of a real machine supported at N_s points and transmitting energy to support structures by both forces and moments. Because three components of force and moment exist at each support, $6N_s$ possible vibration spectra are needed to describe the free velocity; $3N_s\ (6N_s - 1)$ cross spectra are needed if these motions are correlated, as they will be. The same number $3N_s\ (6N_s + 1)$ of input and mutual impedances exist between the various input degrees of freedom of the support points.

Suppose that the N_s components of free motion at the terminals are denoted by $\vec{V}^s = (V_1^s, \ldots, V_{N_s}^s)$. These are the velocities when the forces at these terminals or ports vanish. If forces are present, the actual velocity is diminished by the velocity induced into the source structure through the mobility (matrix inverse of impedance) of the source $\underset{\sim}{Y}^s$.

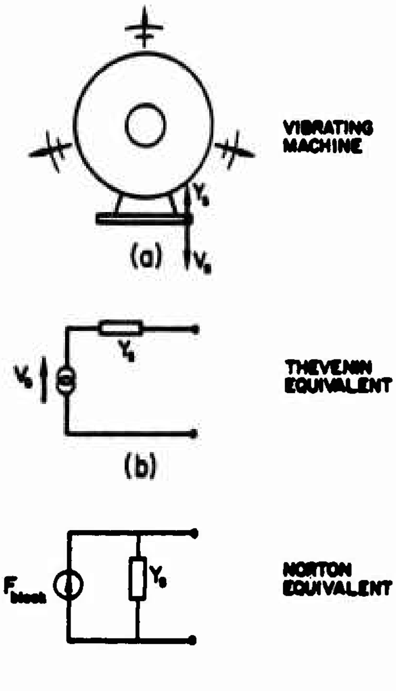


Figure 1. Characterization of Source

*Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139
**Department of Ocean Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139

Such a specification of a source is of course too complicated for equipment suppliers to produce or design engineers to interpret. It is also likely to be unnecessary. Typically, a single component of velocity at each mounting point and as assumption that the internal impedance is defined by machine weight replace the more complex prescription.

Vibration auto- and cross-spectra. The signal processing for determining power spectral densities and cross spectra is highly developed and can be treated as a standard procedure [1]. Measurement of the spectra poses a significant problem in that separation of motion components with such standard sensors as accelerometers is approximate at best. Although accelerometers are able to reject 40 dB of motion transverse to their sensitive axis, their orientation to the precision needed to realize such directional resolution is practically difficult.

Because angular acceleration transducers applicable to source specification were not commercially available until recently, angular velocities at mounting points were measured using differences in linear acceleration [2]. The possibility of contamination from other components of motion was thus greater than with linear measurements. An angular velocity accelerometer has recently become available [6].

Input and mutual impedance. The FFT dual channel analyzer has made the measurement of cross spectra and impedance/mobility functions fast and easy. Force-velocity cross-spectra are straightforward; uncertainties related to cross-axis sensitivity of force sensors affect resolution of acceleration components. The measurement of an internal impedance for a source is essentially the same as for the structural path except that the source impedance can be a considerably simpler function of frequency, depending on the construction of the equipment.

Equipment specifications. The specification of the vibration output of a source must consider the fact that free velocities and internal impedances vary from one sample to another. The designer must realize that any source is part of a population the random parameters of which include such characteristics of free motion as frequencies, phases, and amplitudes as well as internal mobility, particularly at higher frequencies.

The specification of source level -- usually the motion induced into a known load -- is crucial to the design process and the selection of machines for installation. When equipment easily meets specifications, any procedure capable of detecting an exceptionally noisy machine is acceptable. When installation is critical, such special procedures as balancing and high performance mounts must be used. The majority of installations fall in neither category, however.

A basic problem is that sources and structures are variable. One hundred machines installed in one hundred structures produce a distribution of 10^4 response levels. If a fraction of these response levels is unacceptable, the structural noise design is a failure. If the probability of failure is at some tolerable rate, say 10^{-3}, the problem can be worked backward to a requirement on machinery noise input.

Small probability limits on failure are especially sensitive at the extremes of the probability distribution of the response. Most procedures for estimating statistical distributions do not accurately predict extreme values. Methods for predicting extreme values have not been applied to problems of predicting structural noise transmission [3-5].

DESCRIBING THE TRANSMISSION PATH

From the designer's viewpoint the transmission path is described by a transfer function that relates the noise output of a machine to the radiated sound. Such a transfer function can have several components: machine → mounts → supports → structure. Each element can have its own transfer function; overall transmission is expressed as a simple product.

It is easy to show that such an approach is incorrect in detail. If Y_{ab} is the transfer mobility for system 1 (see Figure 2) and Y_{cd} is the transfer mobility for system 2, when system 1 is joined to system 2, as shown in Figure 2, the overall transfer mobility is

$$Y_{ad} = Y_{ab}\, Y_{cd}/(Y_{bb} + Y_{cc}). \qquad (1)$$

The numerator is the product of transfer functions, but the sum of input mobilities of the systems at the junction also contributes to the transfer function.

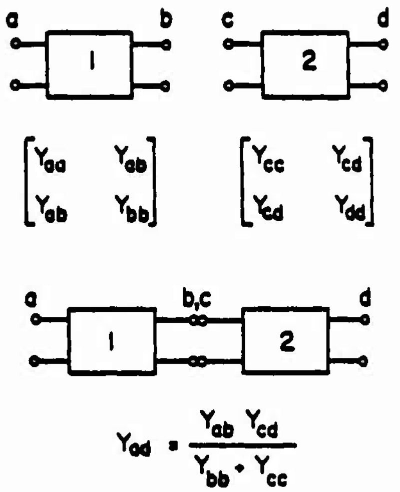


Figure 2. Joining of Two-Port Systems

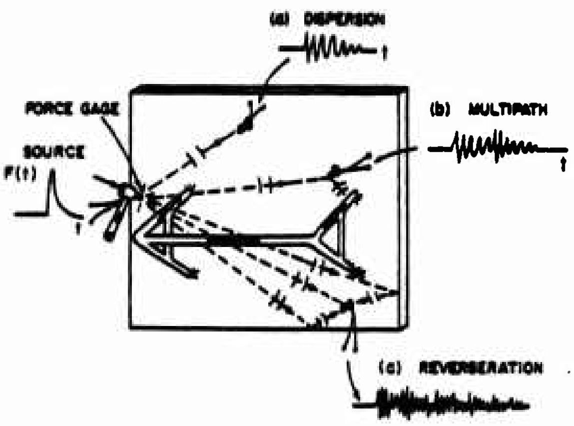


Figure 3. Source of Time Spread in Vibration Signals

If one of the junction mobilities, Y_{cc}, is much larger than the other, Y_{bb}, then

$$Y_{ad} = Y_{ab} \times (Y_{cd}/Y_{cc}) \qquad (2)$$

Equation (2) can be interpreted as the product of two transfer functions, Y_{ab} for sytem 1 and Y_{cd}/Y_{cc} for system 2. The Y_{ab} is the ratio of a velocity at b due to a force at a. The Y_{cd}/Y_{cc} is the ratio of a velocity at d due to a velocity at c.

Single and multipath transmission and reverberation. When a structural system is excited with an impulse, the vibratory response at a second location is usually a time function spread out in time with a great deal of fluctuation. The reasons, given below, are illustrated in Figure 3.

- simple dispersion: because high frequencies travel faster than low frequencies for bending vibrations, the pulse shape is elongated and distorted

- multipath: principal paths of energy propagation in adjacent, connecting structures result in interference among the pulses propagated along each path

- reverberation: multipath propagation within a single structure leads to dense pulse overlap; integrated signal energy is dependent on system damping

Both dispersion and reverberation spread the signal arrivals in time but are due to fundamentally different processes. Reverberation is a form of multipath transmission, primarily in a single substructure.

Statistical formulation of broadband transfer functions. Broadband transfer functions have three main applications. They are used in fundamental studies of vibratory response and transmission: such fundamental quantities as damping, rigidity, mass, and mobility (or impedance) are used to compute vibration response of structural system and to interpret measurements. Transfer functions are also used to interpret measurements made on complex structures. Some statistical estimates of response provide simple predictions of response. The predictions can be used to normalize experimental data, to either explain it or detect experimental effects that are not dealt with or are departures from the statistical model.

Averaged transfer functions can also be used as at the design stage to predict vibratory response or sound levels expected in a system not yet built. This purely predictive role has previously been used less than the more analytical functions; but the costs involved in the classical predictive schemes are generating interest in averaged transfer functions.

Broadband transfer functions are derived using the methods of statistical energy analysis (SEA) [7]. The parameters and derived quantities in SEA formulations include damping loss factors, group and phase wave speeds, and mass densities. The system under study is assumed to be a member of a population, much like an ensemble in statistical mechanics. It is expected that the system under study will display a behavior not too far from the ensemble average.

Narrow-band transfer functions that retain both magnitude and phase are used to predict transient system response. When phase information is ignored and the magnitude of the function is averaged over a frequency interval, a form of transient behavior can be predicted from energy storage and leakage concepts of SEA. Although the analytical framework for such predictions is not well established, the predicted transient behavior seems to agree well with experiments.

Finally, new developments in averaged (or smoothed) transfer functions make use of modern signal processing methods. These techniques allow dereverberation of the signal. The transfer function is thus decomposed into individual paths of energy transmission between source and receiver. It is much too early to assess the potential applicability of these methods to structural noise transmission, primarily because applications thus far have been to nondispersive systems. Almost certainly, however, these techniques will be further developed so that they can be used to study structural vibration.

TRANSMISSION THROUGH STRUCTURAL JUNCTIONS

From a mathematical point of view, any complete structure can be analyzed using global modes and generalized forces. From both practical computational and design engineering purposes, however, it is convenient to substructure a system and deal with the transmission of vibration between substructures in terms of the parameters of individual substructures. Thus, an industrial noise source can be considered in terms of machine, founcation, floor, walls, and sound field. The chain is not necessarily linear: there are likely to be several parallel or flanking paths for vibrational noise transmission.

Substructuring in finite element analysis – component mode synthesis. Component mode synthesis has been described [8]. The method allows system matrices to be established for each substructure and overall system modes to be computed in terms of subsystem modes. Explicit representation of the junction degrees of freedom allows computation of the power transferred between substructures. The power flow computation can be used to estimate transmission directly or to evaluate a coupling loss factor for comparison with averaged SEA coupling loss factors.

Transmission Between Structures -- SEA Formulation

Force transmission in coupled structures – point junctions. If a second structure is connected to the first at the attachment point shown in Figure 4a, the power transmitted into the second structure can be calculated using the diagram shown in Figure 4b.

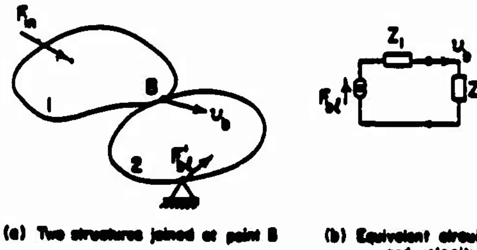
The force transmitted to a rigid support of the second structure is

$$T = \frac{\langle F_b'^2 \rangle}{\langle F_{in}^2 \rangle} = \frac{\bar{G}_1 R_2'}{\omega M_2 \bar{G}_2} \; \frac{1}{\eta_1 \eta_2} \; \eta_{12} \qquad (3)$$

where

$$\eta_{12} \equiv \frac{\Pi_{trans}}{\omega M_1} = \frac{1}{\omega M_1 \bar{G}_1} \; \frac{R_1 R_2}{|Z_1 + Z_2|^2} \qquad (4)$$

Equation (4) is the coupling loss factor that governs the transfer of vibrational energy from structure 1 to structure 2. Damping of both structures reduces force transmission; it is also desirable to reduce the impedance level at the supporting point. If a large impedance discontinuity exists at the junction, transmission is reduced. R_2' is the resistance in structure 2 at its support point.



(a) Two structures joined at point B

(b) Equivalent circuit for force and velocity at B

Figure 4. Scheme for Calculating Power Transmitted Between Connected Structures

Force transmission in coupled structures – line junction. Structures are often joined along weld lines or rows of rivets or bolts. When such point joining is infrequent -- that is, at a distance of half a wavelength or greater – the junctions can be treated as N_C incoherent transmitters. The result is a force transmissibility

$$T(N_C \text{ connections}) = N_C T(1 \text{ connection}) \qquad (5)$$

DeJong [9] recently adapted the results of Swift [10] for transmission through line junctions with a diffuse vibrational field incident; DeJong obtained coupling loss factors between structures.

$$\eta_{12} = \frac{\ell}{k_1 A_1} \left[\frac{1}{1+(k_1/k_2)^4}\right]^{1/4} \frac{R_1^M \; R_2^M}{|Z_1^M + Z_2^M|^2} \qquad (6)$$

In the formulation k_1 and k_2 are free bending wave numbers in the two structures. Z_1^M and Z_2^M are moment impedances for bending waves normal to the junction line, ℓ is the junction length, and A_1 is the area of structure 1.

When the structures on both sides of the junction are of the same type (plates for example), the ratio of impedances that appear in equation (6) can be estimated by the ratios of point impedances. Equation (6) can then be used for experimental estimates of coupling loss factor and force transmissibility.

ESTIMATING TIME-VARYING RESPONSE USING BROADBAND TRANSFER FUNCTIONS

The buildup and decay of vibrational energy in structures is governed by structural parameters that control the storage, dissipation, and transmission of energy. The time scales of buildup and decay are determined by the loss and coupling loss factors. Buildup and decay, known as reverberation, are important in determining the mean square response of any part of a system that is transiently excited. The mean square response as a function of time can be estimated from simple analyses.

Manning [11] has computed time-dependent response and tested the results against experimental data for the system shown in Figure 5a. The supporting truss (structure 1) was transiently excited by an explosive separation nut; the spacecraft (structure 2) response was then calculated. A comparison between computed and observed spacecraft vibration is shown in Figure 5b. The energy vs time result is a good estimate of the envelope of vibration but, of course, provides no details of the time signature.

(a) Sketch of structure (b) Time history of response

Figure 5. Response of Truss-Shell Structure to Transient Excitation

USE OF SIGNAL PROCESSING FOR DIAGNOSING STRUCTURAL VIBRATION SOURCES AND PATHS

Much of the work described in this review is aimed at reducing vibration transmission. Other reasons for analyzing such transmission include source parameter recovery and path analysis. Examples of such analyses are described in this section.

Inverse filtering of vibration pulses using smoothed transfer functions. Because the applications of vibration transmission are usually noise related, simple mean square analysis is adequate. There is increasing interest, however, in using vibration signatures to monitor transient input forces to a structure. Examples might include combustion pulses in diesel engines or impacts in slider-crank mechanisms. Dispersion and reverberation can convert short duration pulses at the excitation point into long duration pulses with complicated time functions of force or motion at a point of observation.

Inverse filtering of vibration on the casing of a diesel engine (see Figure 6a) has been studied [12]. The vibration was due to the combustion pressure pulse shown in Figure 6b. A direct measurement of the phase and magnitude of the transfer function and a smoothing model of the magnitude are shown in Figure 7a. The recovered combustion pulse using this transfer function -- smoothed in magnitude but not in phase -- is shown in Figure 7b. The high quality of combustion pulse recovery shown in the figure is lost if phase smoothing is also employed. Continuing developments can be expected with these linear filtering methods [13-15].

Conventional time and frequency filtering/windowing. Consider the situation in Figure 8, in which $f_{in}(t)$ is a set of pulses; $H(\omega)$ consists of two paths with the frequency characteristics shown. If the frequency filter (window) is such that energy from path #1 is excluded as much as possible from the analysis, the ringing of the filter will tend to obscure the inferred time dependence of $f_{in}(t)$. But if an attempt is made to reduce the ringing by broadening the bandwidth of the filter, low frequency energy, which leaks in from path #2, will affect the inferred form of $f_{in}(t)$.

A problem with linear filtering/windowing is that path and source effects are inextricably bound together by the convolution process. The path characteristics cannot be affected by such processing without modifying the source signature. This interaction can defeat the successful recovery of the characteristics of either.

A common method of path separation and source recovery involves time gating, or windowing. If a single arrival is separated from other arrivals in time, gating allows separation of the nth path from all others. If time delays in the paths are not sufficiently different, gating becomes difficult, either because the pulse lengthens in time due to dispersion or the differences in time delays for various paths become too small. These effects are shown in Figure 9.

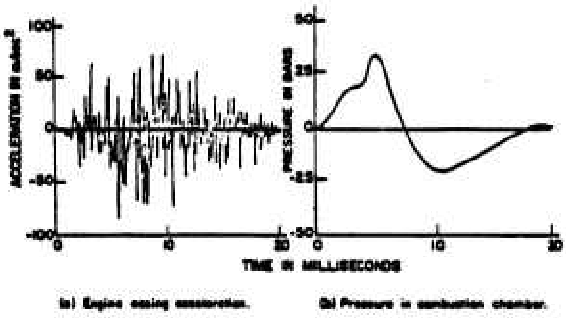


Figure 6. Comparison of Excitation and Response Waveforms in a Dispersive and Reverberant Diesel Engine Structure

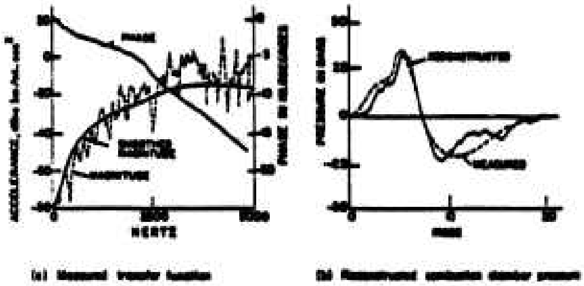


Figure 7. Reconstruction of Combustion Chamber Pressure

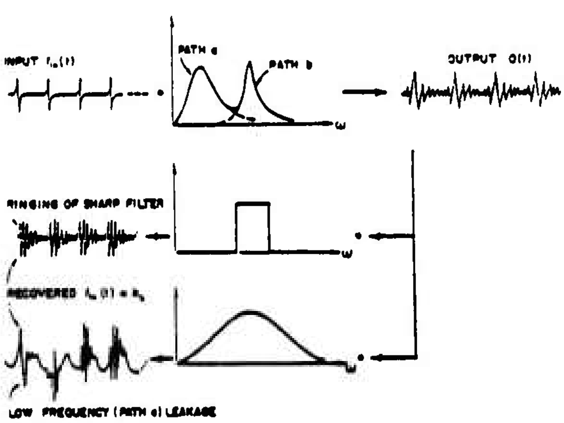


Figure 8. Linear Frequency Windowing of Periodic Signal

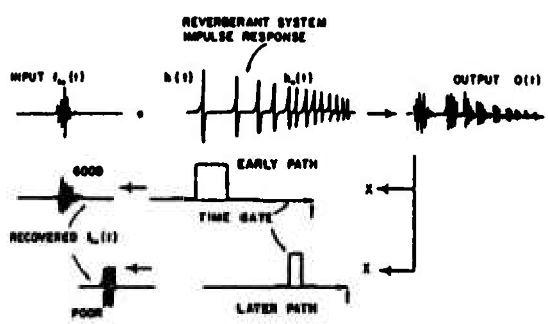


Figure 9. Use of Temporal Windowing to Obtain Path Information on a Reverberant System

Nonlinear filtering – cepstral analysis. A basic problem is convolution of the source and path characteristics. Even if the source is very brief in time, that is, a short pulse, the temporal characteristics are spread over a long time if significant path reverberation is present.

The complex cepstrum of a function ϕ is the inverse fourier transform of the logarithm of the moment generating function or the fourier transform of ϕ [16].

$$C(t) \equiv \frac{1}{2\pi} \int e^{-i\omega t + \ell n M(\omega)} d\omega. \quad (7)$$

If C(t) can be decomposed into C_1 and C_2, the entire chain can be reversed to obtain M_1 and M_2 and in turn ϕ_1 and ϕ_2.

The utility of the cepstrum is that different regions of the t-domain often contribute to distinct and important features of $\phi(t)$ or $M(\omega)$. Situations for which cepstral analysis are generally applicable can be described as follows:

- C_1 is nonzero for small t, and C_2 is nonzero for large t; simple windowing in the t domain determines ϕ_1 and ϕ_2
- values of C(t) for small t correspond to a particular mechanism, which for the impulse response can be a particular propagation path
- large values of C(t) over a narrow range of t (peaks in the cepstrum) correspond to periodic components of $\phi(t)$

These situations have made the cepstrum a useful processing method for smoothing, dereverberation, and source/path identification.

Time delay spectroscopy. Another technique for path separation is known as time delay spectroscopy (TDS). This technique was proposed in 1967 by Heyser [17] for making free field acoustic measurements in a reverberant environment. At its present stage of development TDS has been used to study the acoustics of speakers and rooms. Additional development is necessary before the technique will be directly applicable to the study of vibration transmission in structures.

In a free field or an anechoic environment containing an acoustic source and a receiver, sound generated at the source travels in a straight line at speed c_o to the receiver. In a reverberant environment with no barriers between source and receiver, sound follows other paths in addition to the direct path as shown in Figure 10. These indirect paths are longer than the direct path and thus have a longer travel time. If a suitable time gating technique is used, the signal following the direct path is detected, and the later arriving reflections are rejected.

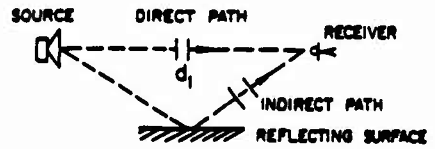


Figure 10. Experimental Arrangement for TDS

Instrumentation for acoustical applications. Figure 11 is a block diagram of the instrumentation required for time delay spectrometry measurements. A swept sine generator is used to drive a speaker. The output of the swept sine generator is heterodyned with a fixed frequency to generate a signal with the proper frequency offset to tune the tracking filter. The intermediate frequency output of the generator is used to generate two side bands sufficiently far apart in frequency that they can be readily separated. Further discussion of instrumentation is available [187].

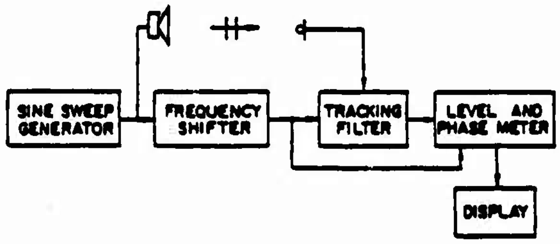


Figure 11. Instrumentation for TDS

Multipath applications. If there are multiple paths d_1 and d_2 and if the difference in path lengths is greater than the spatial resolution ($|d_1 - d_2| > \Delta d$), time delay spectroscopy can be useful in studying the propagation characteristics of the various paths. The sine sweep is repeated as the frequency offset is changed for each sweep by an amount Δf equal to the frequency resolution. The family of curves generated is generally displayed in pseudo three-dimensional form; the origins of successive magnitude curves are offset vertically upward and horizontally to the right.

A typical application of this technique is the study of room acoustics. The speed of sound in structures is typically high enough that differences in arrival times of different paths is too small to be resolved. For a structure the size of a building, however, it might be possible to find sufficiently different arrival times, especially when a longitudinal wave path is being compared to a bending wave path.

Energy arrival times. It has been shown [20] that impulse response is related to the arrival of signal kinetic energy; the Hilbert transform of the impulse response, known as the doublet response, is related to the arrival of the signal potential energy. Transformation of the output of the time delay spectroscopy measurement allows computation of total energy arrival vs time. The theory and the measurement technique have been outlined [19]. The instrumentation involves computing co- and quad-components of the spectrum -- rather than magnitude and phase -- and performing an inverse fourier transform.

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains articles about noise transmission into aircraft and nonlinear analysis of beams.

Dr. R. Vaicaitis of Columbia University, New York, New York has written a survey of literature concerning noise transmission prediction into aircraft. Papers from 1960 through early 1982 are reviewed.

Professor M. Sathyamoorthy of Clarkson College of Technology, Potsdam, New York has written a review of literature on nonlinear analyses of beams limited to papers published since 1972. Geometric, material, and other types of nonlinearities are considered.

RECENT RESEARCH ON NOISE TRANSMISSION INTO AIRCRAFT

R. Vaicaitis*

Abstract. This paper surveys literature concerning noise transmission prediction into aircraft. Papers from 1960 through early 1982 are reviewed. Special attention is given to noise transmission and cabin noise optimization for a propeller driven aircraft.

A recent review [1] presents a general overview for prediction of vehicle interior noise. The present paper elaborates key elements from that survey and includes material on the state of the art of noise transmission analysis and cabin noise in propeller driven aircraft.

STATE-OF-THE-ART OF NOISE TRANSMISSION ANALYSIS

Interior noise in aircraft arises from sources primarily associated with jet engines, propellers, and turbulent boundary layer pressure. Noise enters the aircraft interior through airborne and structure-borne paths. Much attention has been given to subsonic jet aircraft. Helicopter, short-take off and landing (STOL), general aviation, and commuter aircraft have recently been recognized as presenting serious and unique cabin noise problems. Noise levels often exceed acceptable comfort criteria. The many similarities with respect to noise transmission among these vehicles allow construction of a general acoustic-structural analytical model. The acoustic pressure p inside the cabin satisfies the linear wave equation [2-6]

$$\nabla^2 p = \ddot{p}/c^2 \tag{1}$$

where c is the speed of sound in the fluid and ∇^2 is the Laplacian operator [3, 4, 7]. The boundary conditions to be satisfied are

$$\partial p/\partial n = 0 \text{ at rigid boundary} \tag{2}$$

$$\partial p/\partial n = -\rho \ddot{w}_n \text{ at vibrating boundary} \tag{3}$$

$$\partial p/\partial n = -\rho A(\omega)\dot{p} \text{ at absorptive boundary} \tag{4}$$

where n is the normal to the boundary, p is the air density, $\ddot{w}_n$ are the normal accelerations of the flexible portion of the boundary, and $A(\omega)$ is a frequency-dependent acoustic admittance. A more general model of the absorptive boundary has been suggested [9]. The solution to equations 1-4 has been obtained by modal methods [3, 4, 7-18] and finite element procedures [19-28]. After the value for acoustic pressure p is known, interior sound pressure levels can be calculated [29-31].

$$SPL(\underset{\sim}{x}, \omega) = 10 \log (S_p(\underset{\sim}{x}, \omega)\, \Delta\omega / p_o^2) \tag{5}$$

SPL are the sound pressure levels in decibels, $\underset{\sim}{x}$ are the spatial coordinates, ω is frequency in rad/sec, $\Delta\omega$ is the frequency bandwidth, p_o is the reference pressure ($p_o = 2.9 \times 10^{-9}$ psi), and S_p is the spectral density of the acoustic pressure [32].

The modal method is simple, easy to use, and attractive conceptually as a technique for decomposing structural vibrations and the total sound field. It is the determination of these modes that might present difficulty [1].

The disadvantages of the finite element method are large storage requirements (three-dimensional field) and extensive computation time. It is common practice to estimate the acoustic and the structural modes by the finite element method and then solve for the interior noise pressure using a modal approach. Several other methods are also frequently used to estimate noise transmission into enclosures.

**Professor of Civil Engineering and Director of the Institute of Flight Structures, Columbia University, New York, NY 10027*

The classical noise transmission analysis is perhaps the most widely used method for simple practical applications. This method is based on the concept of locally reacting structure of infinite extent, the mass law, and experimental information on the absorption characteristics of acoustic materials [29, 30, 33, 34]. However, for resonant structures, resonant acoustic cavities, and near-tonal inputs (propeller noise) the classical method is not valid.

A fairly new technique known as statistical energy analysis, or SEA, [35-44] has been useful for many problems of noise transmission. The difficulty associated with a large number of structural and acoustic modes is circumvented by averaging a large number of modes over a specified frequency band. The method assumes constant energy over the selected bandwidth and thus might not be suitable for cases in which modes are well separated and inputs are dominated by distinct peaks.

In addition to various theoretical analyses used for noise transmission, a number of experimental studies have been undertaken. Acoustic-structural mode coupling and its importance have been examined [45-50]. Noise transmission into rectangular cavities with one flexible wall has been studied [51-58], and full-scale measurements of actual aircraft have been accomplished [59-69]. Such measurements indicate that interior noise in low damped cavities is dominated by structural and acoustic resonances. Furthermore, for propeller driven aircraft, interior noise is dominated by distinct tone peaks due to propeller blade passage harmonics.

CABIN NOISE IN PROPELLER DRIVEN AIRCRAFT

In propeller driven aircraft, cabin noise arises from such sources as propellers, engine exhaust, turbulent boundary layer, vibration of the engine housing, and such auxiliary devices as air flow units and gearboxes. The sound levels in these aircraft are typically dominated by low frequency noise; noise levels are above those of conventional jet aircraft. Improved methods for controlling interior noise are needed. A review of cabin noise levels is available [70].

A significant amount of analytical and experimental work has been done on noise transmission and control for propeller driven aircraft. These studies can be divided into three categories: general aviation (G/A), turboprop, and advanced turboprop (prop-fan) aircraft. Numerical procedures based on the finite element approach have been developed for small single engine G/A aircraft [26-28, 62, 63]. Some of these results have been verified experimentally. Extensive theoretical and experimental efforts are being directed toward understanding and reducing noise transmission into a twin engine G/A aircraft [16, 17, 38, 61, 65-69, 71, 72]. These analytical models are based on modal analysis in which (uncoupled) in vacuum structural modes and rigid wall acoustic modes are used. A new type of propulsion, the prop-fan, has recently been considered as a possible alternative to the turbofan engine [73]. The noise-related problems of prop-fan aircraft have been studied [43, 44, 74, 75]. Effective and efficient noise reduction techniques are needed to reduce noise to acceptable levels. Among the noise reduction concepts under development are: multiple interior cavities [7, 8], acoustic liners and absorptive wall treatments [9, 12, 76], double walls [18, 43, 58], viscoelastic sandwich panels [15, 77, 78], tuned damping [79, 80], and new structural design concepts [43, 54, 75]. In order that meaningful noise transmission and interior noise optimization models can be developed, it is essential to prescribe proper inputs. Propeller acoustic data for G/A aircraft are available [61, 62, 65-68, 81] as are data for a prop-fan aircraft [73, 82-85].

FUTURE RESEARCH TRENDS

Areas for future research on noise transmission into aircraft are:

- systematic validation of analytical models by experiment
- application of analytical developments to noise transmission prediction and interior noise optimization for turboprop and prop-fan aircraft
- improved understanding of noise reduction by add-on treatments (honeycomb panels, constrained layer damping tapes, acoustic blankets, limp trim panels, impervious barriers)

- full-scale flight testing of prop-fan aircraft
- evaluation of composite materials with respect to noise transmission

ACKNOWLEDGMENT

The author expresses his gratitude to Langley Research Center, NASA, ANRD for their financial support in preparing this paper.

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NONLINEAR ANALYSIS OF BEAMS
PART I: A SURVEY OF RECENT ADVANCES

M. Sathyamoorthy*

Abstract. *This survey of literature on nonlinear analyses of beams is limited to papers published since 1972. Geometric, material, and other types of nonlinearities are considered. Part I deals with literature concerning classical nonlinear methods. Part II reviews recent advances using finite element techniques.*

Various problems in structural mechanics are being solved using linear or linearized equations to represent behavior. Although it is known that linearized equations provide no more than a first approximation of an actual situation, they are sufficient for many practical and engineering purposes. Linearized theory is inadequate, however, if the vibration of an elastic body involves amplitudes that are not very small, as is assumed in linear theory. In addition, problems treated by nonlinear theory exhibit phenomena -- for example, dependence of frequency or period of vibration on amplitude and subharmonic oscillations -- that cannot in principle be handled linearly. In such cases nonlinear theory must be used to obtain more accurate results or to explain new phenomena. The steadily increasing demand for more realistic models of structural responses has resulted in solution techniques to deal with nonlinear structural problems. Modern digital computers have been of great value in solving nonlinear problems.

TYPES OF NONLINEARITIES

In general, nonlinearities in structural mechanics problems can arise in several ways. When material behavior is nonlinear, the generalized Hooke's law is not valid. This type of nonlinearity is called material or physical nonlinearity. Alternatively, material behavior can be assumed to be linear, but structural deformation can become large and cause nonlinear strain-displacement relations. Deformation of a structural member can also be of a magnitude that does not overstrain the material or produce stretching of the medium line; in such a case curvature of the deformed median line can no longer be expressed by a linear equation. Problems involving structural deformation are called geometrically nonlinear problems. Combinations of physical nonlinearity and geometric nonlinearity are also possible.

Static and dynamic responses of structures governed by nonlinearities complicate analytical investigations. The advantages of uniqueness and superposition of solution characteristic of problems governed by linear differential equations do not exist in problems governed by nonlinear differential equations.

Geometric nonlinearity due to stretching. The governing nonlinear equation for large deflection or large amplitude vibration of a beam of uniform cross section can be written as

$$EI\, w,_{xxxx} - \frac{Ebh}{\ell}\left[(u^{o})_{\ell}-(u^{o})_{o} + \frac{1}{2}\int_{o}^{\ell} w,_{x}^{2}dx\right]w,_{xx} = q(x)-\rho w,_{tt} \tag{1}$$

EI is the flexural rigidity, ρ is mass per unit length, h is beam thickness, b is beam width, w is lateral displacement, and u^{o} represents axial displacement along the median line of the beam. If the ends of the beam are immovable, then $(u^{o})_{\ell} = (u^{o})_{o} = 0$. Under these conditions a large lateral deformation or large amplitude vibration produces stretching of the median line of the beam, and the strain-displacement relations become nonlinear. Equation (1) has been derived using the nonlinear strain-displacement relations given below.

**Associate Professor, Department of Mechanical and Industrial Engineering, Clarkson College of Technology, Potsdam, New York 13676*

$$\varepsilon_x = \varepsilon_x^o - z\,w,_{xx} = u^o,_x + \frac{1}{2}\,w,_x^2 - z\,w,_{xx} \tag{2}$$

Geometric nonlinearity due to curvature. If one end of a beam is free to move and undergoes large deformation, the expression for the curvature of the median line can no longer be approximated by a linear curvature-displacement relationship. The nonlinear curvature-displacement relationship can be written as

$$\frac{1}{R} = \pm \frac{w,_{xx}}{[1+(w,_x)^2]^{3/2}} = \pm \frac{w,_{ss}}{[1-(w,_s)^2]^{1/2}} \tag{3}$$

where s is measured along the deformed median line of the beam, and x is measured along the undeformed median line. This expression for curvature can be used to derive the governing nonlinear equation:

$$EI\left[w,_{ssss}(1+w,_s^2) + w,_{ss}(w,_{ss}^2 + 4w,_s w,_{sss})\right] = q(s) - \rho w,_{tt} \tag{4}$$

Equations (1) and (4) can be used to study two types of geometrically nonlinear problems.

Physical nonlinearity of Ramberg-Osgood type. A different type of nonlinearity is due entirely to the nonlinear behavior of the beam material. Very few materials are linear over a wide range of strains and ideally plastic in the inelastic region. Most materials are nonlinearly elastic except in the region close to the origin. The Ramberg-Osgood material model is commonly used to represent nonlinear material behavior. The relationship betwe..n stress and strain for such a model is given by

$$\sigma_x = A\varepsilon_x - B\varepsilon_x^m \tag{5}$$

A and B are constants, and m is an integer. For this type of nonlinear material behavior the governing equations becomesk

$$AI\,w,_{xxxx} - B\left[\frac{b\left(\frac{h}{2}\right)^{m+2}}{(m+2)}\right]\left[m(m-1)(w,_{xx})^{m-2}(w,_{xxx})^2 + m(w,_{xx})^{m-1}w,_{xxxx}\right](m+1) = q(x) - \rho w,_{tt} \tag{6}$$

Equation (6) could be used to study nonlinear static and dynamic behavior of beams with a Ramberg-Osgood type material formula -- that is, characterized by a continuous slope change. Such change is typical of metals at elevated temperatures.

Physical nonlinearity of Ludwick type. A different material stress-strain law has been used primarily for metals that work harden. The relationship is given by

$$\sigma_x = A\varepsilon_x^{1/n} \tag{7}$$

A and n are coefficients of material property. Governing nonlinear beam equations corresponding to this law can be derived for both static and dynamic problems.

Combinations of physical and material nonlinearities are also possible. A beam made of nonlinear material could undergo large deformation with considerable stretching of the median line. Both material and stretching-type geometric nonlinearities occur. Similarly a large deformation accompanied by very little stretching but considerable curvature-displacement nonlinearity could be considered a combination with material nonlinearity. An additional combination can occur when a beam made of nonlinear material undergoes partial stretching and partial nonlinearity due to curvature-displacement relationship. In this case physical nonlinearity is combined with the two types of geometric nonlinearities. Governing equations for any of these cases are derived by following standard procedures.

ARCHES, BEAMS, COLUMNS, AND FRAMES

The literature contains considerable information on linear vibrations of arches, beams, columns, and frames. Surveys by Wagner and Ramamurti [1] and Sayir and Mitropoulous [2] and a book by Henrych [3] deserve mention; some nonlinear vibration problems are also reviewed [1]. Earlier surveys are mentioned below.

Nonlinear deformations of elastic beams, rings, and strings have been reviewed by Eisley [4]; only cases in which geometric nonlinearities arise as a result of large deformations are described, but both static and dynamic problems are considered. Evan-Iwanowski [5] has reviewed the literature on the parametric response of structures, including columns, arches, beams, plates, and shells. In 1971, Schmidt and DaDeppo [6] presented a survey of literature on large deflections of straight and curved beams, rings, and shallow arches.

Sathyamoorthy and Pandalai [7] reviewed the existing literature in the areas of large amplitude vibrations of deformable bodies. Their study was confined to problems in which the nonlinearity is geometric in nature. Although attention focused on plates and shells, beams and arches were included as special cases.

The present review summarizes the literature on nonlinear static and dynamic problems of arches, beams, columns, and frames since 1972. For the most part it is confined to papers written in English.

Many types of nonlinear static problems concerning straight and curved beams, springs, and rings have been considered by Frisch-Fay [8]. This monograph also contains useful references on research conducted prior to 1962. Leissa's monographs [9, 10] on vibrations of plates and shells also contain information on nonlinear problems of beams, rings, and curved members.

A recent book by Nayfeh and Mook [11] deals essentially with nonlinear systems having many degrees of freedom; one chapter is devoted to nonlinear continuous systems. This book provides a wealth of information on nonlinear systems and contains some nonlinear vibration problems concerning beams, rings, plates, membranes, discs, and shells. Classical books on nonlinear problems are listed.

The most recent book on nonlinear analysis of plates is that of Chia [12]. It also contains useful references on beams treated as special cases of plates.

Arches, curved members, and strings. The literature on nonlinear static and dynamic problems of arches, curved members, and springs deals with various problems. Work on the nonlinear theory of arches dates from Euler, who considered not only elastica problems but also those in which structural members had initial curvatures. Large deflections and nonlinear buckling of arches of different types with combinations of boundary conditions have been studied extensively by Schmidt and DaDeppo [13-16], Bayazid [17], Ross [18], and others [19-40]. The large deflection behavior of curved beams has been reported [41-46]. Effects of transverse shear deformation and rotatory inertia on nonlinear static and dynamic behavior of arches have been studied [47, 48]. Nonlinear flexural vibrations of shallow arches and curved elements have been discussed [49, 50]. Extensions of these problems include the effects of transverse shear deformation and rotatory inertia [51-53]. Dynamic buckling of shallow arches has also been investigated [54].

Beams, rods, and columns. Studies on the nonlinear static and dynamic behavior of beams, rods, and columns have attracted several investigators. Geometrically nonlinear problems with various boundary conditions and variable flexural rigidities have been treated [55-99]. The effect of geometric nonlinearity in the design of beam has been considered [67, 68]. Post-buckling behavior [78, 79], snap-buckling of beams with inclined tip load [91], and nonlinear analysis of rods subjected to terminal moments [94] are special problems. In these it has been assumed that material behavior is linear; i.e., the material obeys Hooke's law.

Nonlinear problems involving material nonlinearity have been discussed by Monasa [100, 105, 109, 110] and others [101-114]. The effects of material nonlinearities of the Ramberg-Osgood type [103-104] and the Ludwick type [109, 110] have been discussed. The combined effects of geometric and material-type nonlinearities on the nonlinear behavior of beams have also been investigated [109, 110]. An account of developments in The Netherlands on the nonlinear analysis of structures, including geometric and physical nonlinearities, is available [107].

Effects of transverse shear deformation on the large deflection and post-buckling behaviors of beams have been discussed [115-119], and the behavior of beams resting on nonlinear elastic foundations has been examined [120-122]. Nonlinear analyses of rotor blades treated as beams have been presented [123-126]. Few reports of experimental investigations on nonlinear areas of beams are available. Beams with geometric nonlinearity have been reported [127, 128]. Optimal designs of elastic beams and plates in which large deflections and shear effects have been accounted for have been done [129].

Nonlinear studies of beams undergoing large amplitude flexural vibrations have been reported [130-185]. Responses of beams to periodic loading [133, 149, 156, 159, 165, 167], stability of nonlinear vibrations [131, 132, 176], nonlinear vibrations of beams with time-dependent boundary conditions [142], beams of variable flexural rigidity [144, 160, 166, 169, 172], responses of beams with concentrated masses [144, 159, 169], finite amplitude longitudinal and torsional waves [151, 164, 174], vibrations of rotating shafts with nonlinear spring characteristics [140, 155, 161], effects of axial load on nonlinear vibration of beams [130, 179, 180, 185], thermally induced vibrations [162], and nonlinear vibration behavior of beams with elastic rotational restraints [183] have been considered. Nonlinear responses of beams to random excitations [186] and of structural elements to multi-frequency excitations [187] are special cases of nonlinear forced vibration problems. Modal equations for large amplitude vibrations of beams, plates, rings, and shells have been obtained by Pandalai and Sathyamoorthy [136, 137]. They considered geometric-type nonlinearity due to stretching and observed the nonlinear period-amplitude behavior of flat and curved structural elements.

The effects of material-type nonlinearity on vibration of beams have been considered [188-192]. Effects of transverse shear deformation, rotatory, and inplane inertias on the nonlinear vibration behavior of beams have been investigated [193-198]. Dynamic analyses of sandwich beams and viscoelastic rods have been considered [199-201]. Nonlinear vibrations of rotating blades treated as beams and extensional and flexural vibrations of rotating bars have been studied [202-212]. Among dynamic problems, parametric vibration and dynamic stability of columns and thin-walled beams have been considered [213-228].

Strings, cables, and frames. A class of general solutions to the nonlinear equations governing elastic strings and nonlinear vibration frequencies for a stretched string have been presented [229, 230]. Both nonlinear static and dynamic behavior of cables have been investigated [231-235]. Static nonlinear problems dealing with geometric nonlinearity of frames have been considered [76, 97, 236-242]. The influence of material-type nonlinearity has been discussed [243]. The effect of transverse shear deformation has been studied [244], and dynamic problems have been treated [245, 246].

Considerable research has been done in the areas of nonlinear static and dynamic behavior of general structures and on various techniques for solving nonlinear problems, both static problems [247-260] and dynamic problems [261-280]. The paper by Crandall [268] contains interesting discussion on the role of nonlinearities in structural dynamics problems.

REMARKS

It is clear that a substantial amount of interesting literature exists on various types of nonlinear static and dynamic problems concerned with arches, curved beams, springs, bars, beams, columns, cables, strings, frames, trusses, and structures. More than sixty percent of the papers reviewed here are concerned with beams, columns, and rods. As mentioned earlier, most of these publications make use of classical methods of analysis to find solutions to nonlinear problems. Recently, there has been interest in finite element methods. Part II of this paper is devoted to the application of finite element methods for solving various nonlinear problems.

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BOOK REVIEWS

METAL FATIGUE IN ENGINEERING

H.O. Fuchs and R.I. Stephens
John Wiley & Sons, Somerset, NJ
1980, 318 pp, $33.95

This book is intended for senior and graduate level engineering students and practicing engineers who wish to use modern fatigue and fracture control methods applicable to machines and structures. The book is practical and integrates traditional S-N methods with modern notch strain analysis and linear elastic fracture mechanics.

Chapter 1 gives a brief but interesting and motivating historical overview of the subject. Chapter 2 presents a concise description of fatigue design methods: strategies, design criteria, analysis and testing, probability of failure, and inspection used in fracture control.

Chapter 3 introduces macroscopic and microscopic aspects of common fatigue behaviors. Fractography, cycle dependent softening or hardening, and fatigue mechanisms are described. The illustrations and explanations are concise and easy to understand. However, the references include a few very obscure and hard to get papers, and there is no mention of such important and useful reference books as the ASM Metals Handbook Vol. 9, **Fractography and Atlas of Fractographs.**

Chapter 4 discusses the fundamentals of linear elastic fracture mechanics. This summary of major concepts will be useful to designers of machines and structures.

Chapter 5 covers constant amplitude fatigue tests and data. The relevance of these to random loadings is explained, but some individuals interested in detailed analyses of random vibrations might find the references incomplete. This chapter fairly adequately presents the old and the new. Topics include testing machines and specimens, stress-life curves, fatigue limit, mean stress effects (but not mean strain or prestrain), low cycle fatigue, crack growth rate vs stress intensity factor range, and statistical aspects of fatigue data.

Chapter 6 presents notch effects in adequate detail and properly emphasizes mean stresses and sharp grooves on hard metals. Chapter 7 discusses self stresses and notch strain analysis. This chapter should be of great value to design engineers for its details on the production, permanence, and measurement of self stresses. The notch strain analysis with numerical examples should also be of interest to designers.

Chapter 8 sets forth four approaches for estimating fatigue life under uniaxial constant amplitude loading. Appropriate warnings about uncertainties in practical situations are given.

Chapter 9 discusses the effects of multiaxial stresses and strains in fatigue. The topics covered are yielding, crack initiation, and crack propagation. Some contradictory results are mentioned, but this subject is still being actively researched and is much in need of generally useful methods.

Chapter 10 presents methods for analysis of complex load histories. The linear damage rule is discussed in detail; the lack of an explicit equation for the summation of cycle ratios is a minor shortcoming. Sequence effects are considered. Cycle counting (including the rainflow method) is covered. Simple and sophisticated methods for life prediction and laboratory simulation are described and compared.

Chapter 11 on environmental effects is a valuable and concise treatment of a complex and important group of topics. The chapter covers corrosion fatigue, fretting fatigue, low- and high-temperature fatigue, and neutron irradiation.

Chapter 12 on joints is a relatively brief but relevant treatment of fatigue problems of welds and mechanical fasteners. Chapter 13 is intended to serve as a brief guide to the design of such mechanical components as springs, rolling bearings, and gears, but omits shafts, which are not less important. Again, a few of the references are obscure, and such useful books as ASM Metals Handbook Vol. 10, **Failure Analysis and Prevention** are not mentioned.

The appendices contain monotonic and cyclic properties of common engineering metals and useful data on scatter in fatigue. Each chapter contains valuable comments on dos and don'ts in design. Many of these should be memorized by designers. All in all, this book will be very useful to designers of machines and structures.

B.I. Sandor
Dept. of Engineering Mechanics
University of Wisconsin
Madison, WI 53706

NOISE CONTROL FOR ENGINEERS

H. Lord, W.S. Gatley, and H.A. Evensen
McGraw Hill Book Co., New York, NY
1980, 434 pp, $27.00

This book describes the control of unwanted noise in homes, manufacturing areas, and power plant stations. Identification of noise, its characteristics, and methods for alleviating it are the subjects of the book.

The book contains 11 chapters and an excellent section on laboratory and field experiments. The first four chapters discuss the nature of sound and its measurement in terms of decibel (dB), weighting scales, and octave bands. OSHA requirements are considered, as are general effects of noise on humans. Sound sources, radiated sound fields, and near- and far-field characteristics are considered. The anechoic chamber and reverberation chamber are briefly described.

Part I concludes with a short discussion of the acoustics of room enclosures: absorption and transmissions coefficients, reverberation decay, normal modes of vibration, and steady-state sound pressure levels. The authors adequately describe the fundamental concepts of sound required in noise control engineering.

Part II has to do with practical aspects of noise control. Chapter 5 considers instrumentation for measurement and analysis of noise; frequency analysis, microphones, and sound meters are included. Octave and 1/3 octave band analysis are considered; in the reviewer's opinion power spectral density and autocorrelation should have been discussed because they are often used in noise detection. Determination of reverberation time, consideration of absorption coefficients, acoustic impedance, and measurements of sound power in free and reverberant fields are described, as is attenuation of sound by structures. Airborne sound transmission loss, sound transmission class (STC), impact sound transmission loss, and insertion loss are covered.

Chapter 7 enumerates the various criteria for indoor noise standards and rating schemes for outdoor noise environment. Included are the EPA model community noise control ordinance and descriptions of loudness in terms of the new octave band center frequencies. A discussion of jet engine noise forecast is too brief. This chapter should be expanded to include complete discussions of ratings and community noise control ordinances.

Chapter 8 focuses on acoustical materials and structures, including mechanisms for dissipation of acoustical energy, properties of absorptive structures, and absorption coefficients. The authors present a good section on mufflers used in industry and heating, ventilating, and air conditioning (HVAC) systems. The chapter concludes with transmission loss in panels, damping of panels, attenuation of noise in piping, and single-degree-of-freedom vibration theory. The reviewer was disappointed that no mention was made of measurement of damping using the lug decrement theory.

Chapter 9 describes principles of noise control: identify noise source, list and evaluate possible noise control procedures, identify relative contributions from direct and reflected sound, distinguish between absorption and attenuation of sound, identify and evaluate significance of flanking paths, and identify and evaluate significance of structure-borne noise.

Chapter 10 contains case studies in noise control. Of the eight cases considered the following are the most important in the reviewer's opinion: reduction of engine-generator cooling fan noise, reduction of noise from a wire generator fan, noise reduction of air exhaust and jet thrust device, radiation of mechanical equipment noise in a penthouse, and guidelines for control of airborne direct noise in an HVAC system.

Chapter 11 describes the procedures for establishing an industrial noise control program. They include identification of unacceptable noises, identification of major sources of worker noise, diagnostic measurements, documentation of noise survey, preparation of a noise abatement plan, and assessment of its feasibility. Also important are the establishment of a personal hearing protection plan (educational program) and establishment of an audiometric testing program.

In Part III the authors present eight laboratory experiments on measurement of sound, evaluation of the noise environment, and field assessments of room absorption and reverberation time. A plant noise survey is also included.

This is an excellent book. The reviewer would like expanded sections of noise barrier design and the application of Helmholz resonators to noise reduction of turbojet exhaust systems. Sections on autocorrelation functions applied to noise source identification, valve noise, and combustion noise would be useful. Nevertheless, the book is well written and worth the money. It should be in the library of all noise control engineers.

H. Saunders
General Electric Company
Building 41, Room 307
Schenectady, NY 12345

DAMPING APPLICATIONS FOR VIBRATION CONTROL

P.J. Torvik, editor
ASME Publ. AMD - Vol. 38
New York, NY, 1980

Damping plays an important role in the dynamics of structural response. This book of ten papers discusses various aspects of damping.

A pioneer in damping, W.J. Trapp is the subject of the first chapter. In his role as project engineer for the Air Force Materials Lab (AFML), Trapp sponsored a number of programs in damping.

The second paper describes a number of viscoelastic materials for damping applications from an engineering viewpoint. Dr. David Jones includes physical and mathematical models in his discussion and incorporates time and such effects of frequency as temperature and strain.

The third paper by Dr. Bert reviews damping capacity of fiber-reinforced composites and contains a concise definition of various measures of damping. The current state of the theory is considered for perfectly-bonded viscoelastic composites and those in which slip takes place.

A paper by Professor Plunkett focuses on friction damping, including coulomb damping, microslip in aggregates, and slip damping in riveted joints and between layers of composites. Blade root damping, which is important in gas and steam turbines, is reviewed.

The mechanism associated with panel damping due to sound radiation and air pumping at multi-point fastened joints is described by Dr. Ungar, a pioneer in the field. The procedures required to estimate the corresponding loss factor are given in this important paper on acoustic fatigue of panels.

The editor presents a lengthy discussion of the fundamental principles of constrained layer damping and associated mechanisms. The system parameters employed in determining the effectiveness of constrained layer treatments are described. Emphasis is placed on major achievements in the past two decades and recent investigations.

One paper has to do with the experimental determination of damping in materials and structures. The present methodology is reviewed as are modal testing techniques. The role of the digital computer is emphasized.

Computational methods for treating damping, including spectral damping and the actual physical processes, are reviewed. When incorporated in the modal equation, damped solutions employ the

Newmark B form in both implicit direct time and explicit direct time integrations. Both play important roles in present finite element and finite difference codes.

Two papers consider the application of damping in noise control of diesel engine components and aero propulsion systems. Both are practical papers that contain a great deal of practical knowledge that can be applied to other systems.

This is a good volume that is welcome in the structural dynamics field. The excellent papers bring the reader up to date concerning the latest techniques and methodology in damping.

H. Saunders
General Electric Company
Building 41, Room 307
Schenectady, NY 12345

SHORT COURSES

SEPTEMBER

SIMULATION AND ANALYSIS OF COMPLEX MECHANICAL SYSTEMS

Dates: September 6-10, 1982
Place: Northampton, UK
Objective: The goal is to assist participants in becoming proficient in the formulation of equations of motion of complex mechanical systems. With this background, the participants will be able to produce efficient algorithms for the simulation of motions and for the determination of constraint and control forces arising in connection with such systems.

Contact: The Open University, Walton Hall, Milton Keynes, MK7 6AA, Telephone: Milton Keynes 653945, Telex: 825061.

NOISE AND VIBRATION

Dates: September 13-17, 1982
Place: Southampton, UK
Objective: The course is aimed at researchers and development engineers in industry and research establishments, and people in other spheres who are associated with noise and vibration problems. The course, which is designed to refresh and cover the latest theories and techniques, initially deals with fundamentals and common ground and then offers a choice of specialist topics. There are over thirty lectures, including the basic subjects of acoustics, random processes, vibration theory, subjective response and aerodynamic noise, which form the central core of the course. In addition, several specialist applied topics are offered, including aircraft noise, road traffic noise, industrial machinery noise, diesel engine noise, process plant noise and environmental noise and planning.

Contact: Mrs. G. Hyde, ISVR Conference Secretary, The University, Southampton S09 5NH, UK - Telephone: (0) (703) 559122, Ext. 2310; Telex: 47661.

RELIABILITY TESTING

Dates: September 20-24, 1982
Place: Washington, DC
Objective: This course has been designed to enable participants to calculate the failure rates of components and products; determine the early, chance, and wear-out reliability of components and products; determine the parameters of distributions involved in the time-to-failure data of components and products analytically and by probability paper plotting; conduct chi-square and Kolmogorov-Smirnov goodness-of-fit tests to determine the most appropriate distribution to use; determine the confidence limits on the reliability for the exponential, normal, lognormal, Weibull, and binomial cases; determine the operating characteristic curves of components and products; plan, conduct, and analyze the results of sudden death, suspended-items, percent survival, success run, C-rank, and nonparametric tests; plan, conduct, and analyze the results of sequential, Bayesian, and accelerated tests; and plan, conduct, and analyze tests of comparison for exponential, binomial, and Weibull cases.

Contact: Mr. Stod Cordelyou, Deputy Director, Continuing Engineering Education Program, The George Washington University, Washington, DC 20052 - (202) 676-6106; (800) 424-9773; Telex: 64374.

COMPUTER VIBRATION ANALYSIS

Dates: September 21-24, 1982
Place: Naperville, Illinois
Objective: The course deals with the role of the digital computer in solving vibration problems that arise in design, development, and fault diagnosis; fracture analysis is covered in depth. Applications of the computer to vibration problems associated with modeling, computation, and data handling are reviewed. Selection and use of hardware and software for computer analysis are discussed. The course begins with a review of vibration theory and a discussion of the types of vibration analysis available. Methods for obtaining and processing the physical

data necessary to construct hardware models are described. Readily available and practical short computer programs are summarized, as are such large dynamic programs as NASTRAN, SAP, and ANSYS. Applications of these programs – including pre-processors and post-processors – are elaborated. Methods for predicting vibration failures that utilize fracture mechanics and finite element crack models are applied to such practical problems as generator motors. Available time-sharing services and the computer equipment required for such time sharing are discussed. Microcomputer hardware and software are reviewed and their capabilities summarized.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

SYSTEMATIC APPROACH TO IMPROVING MACHINERY RELIABILITY IN PROCESS PLANTS

Dates: September 28-30, 1982
Place: Toronto, Ontario
Dates: February 23-25, 1983
Place: San Francisco, California
Objective: This seminar is intended to guide machinery engineers, plant designers, maintenance administrators, and operating management toward results-oriented specifications, selection, design review, installation, commissioning, and post start-up management of major machinery systems for continued reliable operations. Emphasis will be on pumps, compressors, and drivers.

Contact: Sherry Theriot, Professional Seminars International, P.O. Box 156, Orange, TX 77630 - (713) 746-3506.

TORSIONAL VIBRATIONS

Dates: September 28-30, 1982
Place: Oak Brook, Illinois
Objective: The course emphasizes methods for diagnosing and solving torsional vibration problems in existing equipment. Methods for controlling and eliminating torsional vibrations during the machinery design process are also described. Examples and case histories are used to illustrate mathematical and experimental techniques. The introductory lectures include a short review of basic torsional vibration concepts and a classification of excitations from various types of machines. A discussion of natural frequencies, mode shapes, critical speeds, and torsional vibration response includes the relationship of these factors to mechanical design and analysis. Such criteria for evaluating torsional vibration as strength and motion are discussed, as is the application of these criteria to solving machine problems; allowable stresses and motions are given. Requirements, sources, and techniques for measuring and calculating parameters for the acquisition of design data are topics for several lectures. Data from blueprints and physical measurements are used to model systems and components for such parameters as stiffness, damping, and mass. Models of physical systems, explicit formulas, and the Holzer method are used to calculate such parameters as natural frequencies and mode shapes. Several lectures are devoted to steady and transient forced vibration responses and include the measurement and analysis of motions and stresses. Techniques involved in premeasurement, calibration of sensors, and actual measurement of forced vibration are discussed and demonstrated. Case histories are used to illustrate what, where, and how to measure and analyze specific torsional vibration problems on such components as pumps, compressors, gearboxes, engines, motors, and couplings. Torsional/lateral interactions in rotors, gearboxes, and pumps are described. Such techniques of vibration control as tuning, reduction of excitation, damping, and isolation are elaborated. Selection of the proper coupling for vibration control and for capability to prevent misalignment is emphasized.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

OCTOBER

UNDERWATER ACOUSTICS

Dates: October 4-8, 1982
Place: University Park, Pennsylvania
Objective: This course provides a broad, comprehensive introduction to underwater acoustics and related topics that are of immediate practical value. It also serves as a foundation for more advanced study of current literature or other specialized courses. The two parts of the course are: Basic Concepts: a two-

day heuristic overview of the fundamentals of underwater acoustics, including general acoustics, sonar engineering, transducer principles, and underwater propagation; and Advanced Topics: a three-day in-depth study of three specialized or advanced topics chosen by the student, according to the needs of both the individual and the employer.

Contact: Robert E. Beam, Conference Coordinator, The Pennsylvania State University, Faculty Building, University Park, PA 16802 - (814) 865-5141; TWX 510-670-3532.

VIBRATION CONTROL

Dates: October 11-15, 1982
Place: University Park, Pennsylvania
Objective: The seminar emphasizes principles, general approaches and new developments, with the aim of providing participants with efficient tools for dealing with their own practical vibration problems.

Contact: Mary Ann Solic, Pennsylvania State University, 410 Keller Conference Center, University Park, PA 16802 - (814) 865-4591, TWX No: 510-670-3532.

MAINTAINABILITY AND AVAILABILITY ENGINEERING OF EQUIPMENT AND SYSTEMS

Dates: October 18-22, 1982
Place: Los Angeles, California
Objective: This course should give top management an understanding of the great cost benefits that accrue through the implementation of maintainability and availability engineering methodologies, and participants should be able to determine the following: the distribution of times-to-repair components and times-to-restore equipment; the equipment mean-time-to-restore; the mean man-hours needed to restore; the optimum preventive maintenance schedules for minimum total corrective and preventive maintenance cost; spare parts requirements and their optimization; the reliability, maintainability and availability (both instantaneous and steady state) of maintained equipment and systems. Numerous applications are presented. Course participants' problems will be solicited and solutions given or suggested.

Contact: Mr. Robert Rector, Assistant Director - Short Courses, UCLA, 6266 Boelter Hall, Los Angeles, CA 90024 - (213) 825-3496.

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: October 18-22, 1982
Place: Boston, Massachusetts
Dates: November 15-19, 1982
Place: Santa Barbara, California
Dates: December 8-12, 1982
Place: Huntsville, Alabama
Dates: February 7-11, 1983
Place: Santa Barbara, California
Dates: March 7-11, 1983
Place: Washington, DC
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos St., Santa Barbara, CA 93105 - (805) 682-7171.

NOVEMBER

MACHINERY VIBRATION ANALYSIS

Dates: November 9-12, 1982
Place: Oak Brook, Illinois
Objective: In this four-day course on practical machinery vibration analysis, savings in production losses and equipment costs through vibration analysis and correction will be stressed. Techniques will be reviewed along with examples and case histories to illustrate their use. Demonstrations of measurement and analysis equipment will be conducted during the course. The course will include lectures on test equipment selection and use, vibration measurement and analysis including the latest information on spectral analysis, balancing, alignment, isolation, and damping. Plant predictive maintenance programs, monitoring equipment and programs, and equipment evaluation are topics included. Specific components and equipment covered in the lectures

include gears, bearings (fluid film and antifriction), shafts, couplings, motors, turbines, engines, pumps, compressors, fluid drives, gearboxes, and slow-speed paper rolls.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

NEWS BRIEFS: news on current and Future Shock and Vibration activities and events

Call for Papers

INSTITUTE OF ENVIRONMENTAL SCIENCES' 29TH ANNUAL TECHNICAL MEETING
April 18-21, 1983
Marriott Hotel, Los Angeles, California

Technical papers are welcome in the following and other related areas. Abstracts of 300 words or less must be submitted by September 19, 1982 to insure their consideration. Complete text of technical presentation will be required in the proper format for Proceedings publication by January 20, 1983. Authors should recognize the responsibility of their commitments to this schedule when the initial submittal is made. Suggestions for session chairmen and panel moderators are also welcome.

Environmental Stress Impact

- Standards and practices (210C, 781D, 785D, 810D)
- Recommended practices, reliability/environmental
- Environmental stress screening
- Combined environment testing
- Reliability analysis and environmental integration
- Reliability in the production cycle
- Reliability modeling
- The payoff of quality enhancement

Energy and the Environment

- Energy and economics
- Dealing with regulations
- Potential of alternate energy sources
- Energy facility problems and solutions
- Recycling and resource recovery
- Climatic impact
- Hazardous materials control
- Effects assessment

Environmental Engineering Methods

- Low cost testing
- Successful test tailoring
- Reliability growth
- New techniques in testing
- Analysis of dynamic data
- Severe environment simulation
- Unique facilities
- Automation in the laboratory

Send abstracts to: ATM 83 Technical Program Committee, Institute of Environmental Sciences, 940 E. Northwest Highway, Mount Prospect, IL 60056 - (312) 255-1561.

INTERNATIONAL MODAL ANALYSIS CONFERENCE
November 8-10, 1982
Orlando, Florida

The First International Modal Analysis Conference will be held at the Holiday Inn, International Drive, Orlando, Florida, November 8-10, 1982. This is the first-known conference devoted exclusively to the technology of modal analysis of vibrating structures. More than 100 technical papers from 16 countries will be presented, dealing with both analytical and experimental methods in modal analysis. A comprehensive exhibit of modern modal analysis equipment will be shown by leading firms. The conference is sponsored by Union College of Schenectady, New York.

For further information contact: Mrs. Rae D'Amelio, Graduate and Continuing Studies, Union College, Wells House, 1 Union Ave., Schenectady, NY 12308 - (518) 370-6288.

MECHANICAL VIBRATION AND NOISE CONFERENCE
September 12-14, 1983
Dearborn, Michigan

The ninth biennial ASME Design Engineering Division Conference on Mechanical Vibration and Noise will be held as part of the 1981 Design Technical Conference in Dearborn, Michigan, September 12-14, 1983. The Detroit section of ASME will be the host. The

Conference Chairman is Dr. A.V. Srinivasan, United Technologies Research Center, Silver Lane, East Hartford, CT 06108 - (203) 727-7211.

Papers covering advanced analytical and experimental research efforts in all aspects of vibration engineering are solicited and should be directed to session coordinators shown in each of the following areas. Papers of broad interest that may not fall into the topic areas listed below should be submitted to Associate Conference Chairman, Dr. P. Niskode, Aircraft Engine Group, MD K71, General Electric Company, Cincinnati, OH 45215 - (513) 243-4783. Abstracts should be submitted to the appropriate coordinators by September 15, 1982 on ASME form MSP 1903 which may be obtained from ASME Headquarters at 345 E. 47th St., New York, NY 10017. Acceptance of abstracts will be communicated to individual authors by October 15, 1982. Completed manuscripts, in quadruplicate, prepared in accordance with accepted ASME standards, are due by December 1, 1982. Papers which may qualify for publication also will be published in the Journal of Mechanical Design.

Vibration of bladed disk assemblies. Blade and blade group vibration, blade disk interaction, system modes, forced vibration and flutter, excitation mechanisms, experimental and test observations, blade damping techniques. Contact Dr. D.J. Ewins, Department of Mechanical Engineering, Imperial College of Science and Technology, Exhibition Road, London SW7 2BX, England - Telephone: 01-589-5111. Please note that accepted papers will be published in the form of symposium volume entitled "Advances in Structural Dynamics of Bladed-Disk Assemblies" to be edited by Drs. A.V. Srinivasan and D.J. Ewins.

Structural parameter identification. Theory and application of the use of test data to identify structural parameters including: mass, damping and stiffness matrices; normal modes and frequencies; transfer function; or physical characteristics of linear or nonlinear dynamic structures. Contact A. Berman, Kaman Aerospace Corporation, P.O. Box 2, Bloomfield, CT 06002 - (203) 243-7215.

Rotor dynamics. Balancing, stability, synchronous and nonsynchronous response, transients, torsional vibration, vibration control with damped rotor-bearing systems. Contact David Hibner, Engineering 3S-3, Mail Stop 163-9, Pratt and Whitney Aircraft, East Hartford, CT 06108 - (203) 565-2238.

Vibration reduction and control. Passive and active vibration isolators, vibration absorbers, design of dampers and damping treatments. Contact Dr. R.L. Eshleman, The Vibration Institute, Suite 206, 101 W. 55th St., Clarendon Hills, IL 60514 - (312) 654-2053.

Structural dynamics. Advances in analytical methods of solution of vibration problems, substructure methods, component mode synthesis and/or simulation of vibrating systems, nonlinear and random vibration, statistical methods. Contact Dr. J.L. Krahula, Hartford Graduate Center, 275 Windsor St., Hartford, CT 06120 - (203) 549-3600.

Finite element analysis of vibration and sound problems. Finite element applications to industrial vibration and/or sound problems, solutions for vehicle vibration and noise problems using finite elements, other practical applications, comparisons and evaluation of accuracy. Contact Drs. Mounir Kamal and Joseph A. Wolf, Jr., Engineering Mechanics Department, General Motors Research Laboratories, Warren, MI 48090 - (313) 575-2929 and 575-3378.

Analytical methods for minicomputers. Advances in methods of vibration analysis suitable for preliminary design and parametric studies utilizing minicomputers, desktop computers or programmable hand calculators to solve vibration problems. Contact Professor A.W. Leissa, Department of Engineering Mechanics, Ohio State University, 155 W. Woodruff, Columbus, OH 43210 - (614) 422-2680.

Acquisition and reduction of vibration data. Time series analysis, spectral methods, shock response analysis, experimental modal analysis methods, impedance information by experimental means, holographic methods. Contact Drs. Albert Klosterman and Havard Vold, Structural Dynamics Research Corporation, 2000 Eastman Drive, Milford, OH 45150 - (513) 576-2400.

Machinery and transportation noise. Noise characteristics, noise sources and paths, vibration induced noise, coherence and correlation methods, spectral methods, acoustic radiations, wheel-rail interaction, tire noise and vibration, techniques of noise reduction. Contact Dr. Richard Madden, Bolt, Beranek and

Newman, 50 Moulton St., Cambridge, MA 02238 - (617) 497-3391.

Mechanical signature analysis. Diagnostic techniques, defect identification, analytical and computational methods, applications to rotating machinery, structural testing, process monitoring and noise reduction. Contact Dr. Simon Braun, Faculty of Mechanical Engineering, Technion - Israel Institute of Technology, Haifa 32000, Israel.

Fluid structure interaction. Vortex induced vibration, flutter, vibration caused by oscillating flows, turbulent buffeting of structures, instabilities in tube arrays, seal systems, leakage-flow-induced vibrations. Contact Dr. Frank T. Dodge, Southwest Research Institute, Department of Mechanical Sciences, P.O. Drawer 28510, San Antonio, TX 78284 - (512) 684-5111, Ext. 2306.

Special session on work in progress. The 1983 Conference will, in addition, feature a single special session in which works in progress may be presented. This session is planned to provide an opportunity for researchers to present orally their most recent efforts. No formal preprints or publication is planned. Abstracts of these oral reports should reach Dr. Richard D. Rocke, Building 600/D-131, Hughes Aircraft Co., Fullerton, CA 92634 - (734) 732-4638 no later than July 15, 1983. Accepted abstracts will be communicated to the individual presenters by August 15, 1983.

ADVANCES IN DYNAMIC TESTING AND ANALYSIS

SAE Aerospace Congress & Exposition
Anaheim Convention Center
October 25-28, 1982

Papers on "Dynamic Analysis and Testing" will be presented at two sessions during the 1982 SAE Aerospace Congress and Exposition, week of October 25, 1982 at the Anaheim Convention Center, Anaheim, California. These two sessions are being organized by the SAE Technical Committee G-5 on Aerospace Shock and Vibration. The G-5 Committee has organized shock and vibration sessions at each SAE national aeronautic or aerospace meeting since 1957. The G-5 Committee was formed December 8, 1955 with Dr. C.T. Molloy as Chairman, and the committee selected as its primary task, the production of a document on the design of vibration isolation systems for aircraft missiles and spacecraft. In 1962 the SAE published the G-5 document "Design of Vibration Isolation Systems" as part of the SAE series of "Advances in Engineering," Volume 3.

The G-5 membership was selected from experienced practitioners in the field of shock and vibration control all over the United States. There were two types of memberships, namely, active members and consultants. The classification of membership was based primarily upon geography. It was assumed that members living in the vicinity of Los Angeles would be willing and able to participate actively in the work of the committee. They therefore automatically were designated as active members unless they requested otherwise. Committee meetings were held monthly in Los Angeles for many years. Presently the meetings are held monthly at the Aerospace Corporation in El Segundo, California. The present chairman of the G-5 Committtee is Dr. Sheldon Rubin of the Aerospace Corporation. New members are welcome to join the G-5 Committee and may do so by contacting Dr. Rubin at the Aerospace Corporation, (213) 648-6408.

Preliminary information on the G-5 technical sessions may be obtained from Roy W. Mustain, Rockwell Space Systems Group, Mail Sta. AB97, 12214 Lakewood Blvd., Downey, CA 90241. The final program for the 1982 SAE Aerospace Congress & Exposition may be obtained by writing to: SAE, 400 Commonwealth Dr., Warrendale, PA 15096.

PRELIMINARY PROGRAM

Morning -

Chairman: Dr. Robert Emmett Holman, Hughes Aircraft

Asst. Chairman: Dr. C. Thomas Savell, Dynamic Analysis & Testing Associates

Interaction of Structures & Controls for Robotic Manipulators – W. Sunada, Hughes Aircraft

Flexibility Monitoring of Offshore Fixed Platforms – Dr. Sheldon Rubin, The Aerospace Corporation

Finite Element Modeling Techniques for Constrained Layer Damping – C. Johnson, Anamet Labs

Summary of Shuttle Payload Dynamic Measurements – W.F. Bangs, NASA Goddard Space Flight Center

Pulse Excitation Techniques – Dr. F.B. Safford, Agbabian Associates

System Identification & Model Integration Techniques Using Sinusoidal Excitation – Kenneth D. Blakely and Dr. Michael W. Dobbs, ANCO Engineers, Inc.

Afternoon -

Chairman: Mr. R[illegible] E. Allen, Rush Engineering Associates

Asst. Chairman: Dr. Gerard C. Pardoen, U.C. Irvine

Computing Spacecraft Transfer Functions Using Base Sine Excitation Data – John Fowler, Hughes Aircraft Co.

Seismic Qualification Using Single Point Random & Base Excitation Transfer Functions – Jim Steedman, National Technical Systems, Inc.

Multi-Point Excitation Techniques for System Identification – Dr. Richard C. Stroud, Synergistic Technology, Inc.

Multi-Point Random Vibration Excitation & Control – David O. Smallwood, Sandia Labs.

Dynamics Testing & Vibration Control Algorithms – Emmet Dancy, Hewlett Packard Co.

Shock Response Analysis & Frequency Response Functions – Dr. Gerard C. Pardoen, U.C. Irvine

INFORMATION RESOURCES

THE SHOCK AND VIBRATION INFORMATION CENTER (SVIC)

ORIGIN

The Center was established at the Naval Research Laboratory as the Centralizing Activity for Shock and Vibration. Under the leadership of Dr. Elias Klein the Activity was to be the mechanism for "a coordinated attack on Navy shock and vibration problems." The first principal service effort began with a symposium held in January 1947. This series of meetings continues as the Shock and Vibration Symposia, the 53rd of which will be held in October 1982. By 1949 the Army and Air Force had become sponsors and the Activity served all of the DoD. In 1962, the National Aeronautics and Space Administration formally became the fourth sponsor. Over the years the mission and services expanded and, in 1964, SVIC assumed its present name and became an official DoD Information Analysis Center. SVIC has had four directors.

- Dr. Elias Klein . . . . 1946 - 1958
- Dr. W.W. Mutch . . . . 1958 - 1972
- Dr. R.O. Belsheim . . . . 1972 - 1973
- Mr. Henry C. Pusey . . . . . 1973 - Present

MISSION AND SCOPE

As a Department of Defense Center for the Analysis of Scientific and Technical Information, SVIC has the following mission.

- The Center collects, evaluates, and stores information on current and past studies of mechanical shock and vibration technology. This includes shock or vibration effects on structures, equipment or humans that may be generated by acoustic, mechanical, or other physical phenomena.
- It reviews, analyzes and disseminates this information to the user.
- It encourages the solution of shock and vibration problems.

Some of the specific areas of shock and vibration information handled by SVIC include:

Instrumentation and measurement techniques
Test techniques
Prediction of dynamic environments
Design of equipment and structures
Dynamics of materials
Isolation and damping
Dynamic analysis
Structural analysis
Reliability
Mechanical impedance
Human response
Survivability/Vulnerability

SERVICES

Shock and Vibratk n Symposia. The Shock and Vibration Symposia that have been held constitute one of the largest single sources of information in this technological area. Attendance has varied from several hundred to a thousand, consisting mostly of scientists and engineers with a sprinkling of managers and technicians. Many of the papers and discussions presented at the symposia are unclassified. The distribution of some papers is limited and others are classified. Attendance at the classified sessions require establishment of an individual's clearance and need-to-know. A symposium usually lasts three days, permitting the presentation of about a hundred papers in two parallel sessions. The aims of these symposia are:

- To bring together working scientists and engineers for formal presentations of their papers and for informal information exchanges.
- To encourage the presentation of worthwhile studies and developments.
- To define the "state of the art."
- To point out problem areas for future study.

Shock and Vibration Bulletins. A Shock and Vibration Bulletin is published following each symposium. Bulletins 1 through 52 are the proceedings of the corresponding symposia, and include all programmed papers, edited discussions, and a few additional papers. Currently, all papers are critically refereed before being accepted for publication. Most papers published in this series add to the total knowledge in the shock and vibration field; others define the state-of-the-art and point the direction for future efforts.

The Shock and Vibration Digest. In 1969 SVIC began publication of a monthly abstract and review journal, a current awareness publication which the reader now holds in his hand. The Digest therefore needs no further description in this brief.

Shock and Vibration Monographs. In an era when working scientists and engineers can no longer keep up with the literature explosion, an information analysis center is an organization which has as part of its mission the evaluation, condensation and consolidation of the useful literature. SVIC performs this function in part by publishing state-of-the-art monographs written by experts on various aspects of shock and vibration technology. The object is to gather together the highly fragmented literature, extract significant material, standardize the symbolism and terminology, and provide an authoritative, condensed review, with bibliographies which can be used with little or no reference to the original papers. Eleven such monographs have been published and several others are in process.

Special Publications. Special surveys, indexes and bibliographies are produced when the need arises. Several special publications of this type have been issued over the last several years.

Work in Progress. Each year personnel of the Center visit leading government, industrial, and educational laboratories and engineering departments to promote information interchange. In the past decade, more than 300 different activities have been visited for the purpose of making these direct contacts. Mutual exchanges of this kind provide considerable first-hand information about current work in the field and serve as direct means of keeping the Center staff aware of new developments. Much of this information may not reach the publication stage for some time, while some will never be published. Nevertheless, it is available at the Center and, when appropriate, is passed on in many ways to users.

Direct Information Service. The center handles requests for information via mail, telephone, and direct contact. An analysis of these queries shows that over 90 percent fall into seven general categories:

- What is the environment which controls a given design?
- How can equipment be protected?
- How can a given test be conducted?
- Where can a test facility or a piece of test equipment be found?
- What analytical techniques are available?
- How can specialized measurements be made?
- What are the dynamic properties of materials?

These requests are answered as expeditiously as possible -- often immediately, if received by phone or direct contact. They usually result in pertinent references and referrals to senior investigators and engineers who have direct knowledge of the requested information. To assist the staff members at the Center a bibliographic data base has been established containing in part the titles and authors which have appeared in previous issues of the Shock and Vibration Digest indexed by key words. Members of the Center access this base via time sharing computer terminal and perform retrospective literature searches or other studies related to the information needs of the users. Occasionally, under special funding arrangements, staff members will, as time permits, perform extensive literature searches or studies as required by the users.

Queries about the services and publications of the Center may be addressed to:

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Washington, DC 20375
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Rudolph H. Volin
J. Gordan Showalter
Jessica P. Hileman
Elizabeth McLaughlin

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (UM), 313 N. Fir St., Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, DC 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

constructed from the generalized eigenvalue problem using a recently developed numerical technique. Results obtained through this computer package are compared with those already available in the literature.

ROTATING MACHINES

(Also see Nos. 1674, 1675, 1677, 1684, 1739, 1774, 1807, 1810, 1811, 1838)

82-1583

Eigenvalue Derivatives for Damped Torsional Vibrations

S. Doughty
Dept. of Mech. Engrg., Texas A&M Univ., College Station, TX 77843, J. Mech. Des., Trans. ASME, 104 (2), pp 463-465 (Apr 1982) 1 fig, 6 refs

Key Words: Rotating machinery, Natural frequencies, Torsional vibration, Damped structures, Eigenvalue problems

In the design of rotating machinery, it is often necessary to project design changes in order to modify the system torsional natural frequencies. For damped systems, there are additional questions regarding the change in modal decay rates associated with a parameter change. This paper provides a simple, easily implemented procedure to calculate the derivatives of the complex eigenvalue for the damped torsional system when the eigensolution is known.

82-1584

A Numerical Approach to the Stability of Rotor-Bearing Systems

K. Athre, J. Kurian, K.N. Gupta, and R.D. Garg
Industrial Tribology, Machine Dynamics and Maintenance Engrg. Ctr., Indian Inst. of Tech., Delhi, New Delhi, 110016, India, J. Mech. Des., Trans. ASME, 104 (2), pp 356-363 (Apr 1982) 13 figs, 8 refs

Key Words: Rotors, Stability, Numerical analysis

The stability characteristics of a rotor-bearing system which indicate the threshold of instability are generally obtained by applying the Routh-Hurwitz criterion to the characteristic polynomial. Usually the characteristic polynomial is obtained analytically from the characteristic determinant. In the case of the generalized eigenvalue problems, this is practically impossible. To study the stability characteristics of a floating bush bearing, the characteristic polynomial is

82-1585

A Note on Critical-Speed Solutions for Finite-Element-Based Rotor Models

D.W. Childs and K. Graviss
Mech. Engrg. Dept., Texas A&M Univ., College Station, TX 77843, J. Mech. Des., Trans. ASME, 104 (2), pp 412-416 (Apr 1982) 2 figs, 4 refs

Key Words: Rotors, Critical speeds, Finite element technique

An ordering scheme is introduced for the deflection variables in finite-element-based rotordynamics models which permits a direct numerical solution approach via symmetric matrix procedures for rotor critical speeds, providing the system stiffness matrix is symmetric. Previously published reports on finite-element formulations employ general Q-R algorithms operating on state-variable forms of the governing equations to obtain rotor natural frequencies at a specified running speed, with critical speeds determined from many such calculations.

82-1586

Passage of a Rotor through a Critical Speed

K. Tsuchiya
Central Res. Lab., Mitsubishi Electric Corp., 80 Nakano, Minami Shimizu, Amagasaki, Hyogo, Japan 661, J. Mech. Des., Trans. ASME, 104 (2), pp 370-374 (Apr 1982) 8 figs, 8 refs

Key Words: Rotors, Critical speeds, Resonance pass through

This paper deals with a nonstationary oscillation of a rotor passing through a critical speed. The analysis is based on the method of multiple scales and the method of matched asymptotic expansion. The peak amplitude of the response and the criteria for the onset of the stalling (inability to pass through the critical speed) are derived. These results are compared with those of digital computer simulation.

82-1587

Transverse Vibrations of a General Cracked-Rotor Bearing System

T. Inagaki, H. Kanki, and K. Shiraki

Vibration and Noise Control Res. Lab., Takasago Tech. Inst., Mitsubishi Heavy Industries, Ltd., Takasago, Japan, J. Mech. Des., Trans. ASME, 104 (2), pp 345-355 (Apr 1982) 11 figs, 7 tables, 10 refs

Key Words: Rotors, Crack detection, Flexural vibration, Diagnostic techniques

In this study, the steady state response to the gravity and the unbalance force, and the major natural vibration of a general rotor bearing system with the open or open-close type crack, is analyzed along the iterative numerical calculation method (the transfer matrix method). The open-close type crack is idealized as a step function of the bending moment. The nonlinear equations are linearized by using the Fourier expansion technique, and its solutions are given approximately with the static deflection, the once/rev. vibration, and the twice/rev. vibration. The analyzed calculated method is confirmed by comparing the calculations with the experiments for a small test rotor.

82-1588

Method of Determining Locations of Unbalances in Rotating Machines

K. Shiohata, F. Fujisawa, and K. Sato

Mech. Res. Lab., Hitachi, Ltd., Ibaraki-ken, 317, Japan, J. Mech. Des., Trans. ASME, 104 (2), pp 290-295 (Apr 1982) 8 figs, 1 table, 8 refs

Key Words: Rotors, Unbalanced mass response

This paper presents a method of determining the locations of unbalances on a rotor when the unbalances occur abruptly during rotor running. The method makes use of journal vibrations, because, generally, there is a relation between the locations of unbalances and the unbalance vibration modes of a rotor. At critical speeds, where this relation is particularly significant, the phase angle of an unbalance vibration shifts 90 deg, and unbalance distributions excite vibration modes. Which mode or modes is excited depends on the location of an unbalance on a rotor. In this paper, a rotor is assumed to be divided lengthwise into three sections on which unbalances are assumed to be distributed. A simple algorithm, which is derived from the characteristics of the foregoing vibrations and assumptions, allows four unbalance distributions to be determined on a rotor, at the center, on either side (right or left side), on the right and left sides (out of phase), and on the right and left sides (in phase) of a rotor.

82-1589

A Short-Cut Method of Working Out Equations to Describe Small Oscillations of the Complicated Rotor Systems

E. Bogorod, V. Zhakharov, A. Kelzon, and A. Ščerbakov

Vibrotechnika, 2 (32), pp 77-88 (1981) 3 figs, 4 refs

Key Words: Rotors, Computer programs, Low frequencies

A method for solving equations describing small oscillations of a complicated rotor system is presented. The article also deals with the interference of rotor oscillations, their dynamic properties and the dynamics of complicated rotor systems. A computer program is also developed.

82-1590

Vibrations of an Elastically Mounted Spinning Rotor Partially Filled with Liquid

G. Lichtenberg

Inst. f. Maschinenelemente und Foerdertechnik, Technische Univ. Braunschweig, Langer Kamp 19 B, D-3300 Braunschweig, Germany, J. Mech. Des., Trans. ASME, 104 (2), pp 389-396 (Apr 1982) 5 figs, 1 table, 11 refs

Key Words: Rotors, Fluid-filled containers, Elastic foundations, Vibration analysis

The stability of a rotor with a cylindrical cavity, spinning with constant angular velocity and partially filled with an inviscid, incompressible fluid is studied. The rotor is elastically supported on a vertically mounted massless shaft in overhung position. A set of coupled linearized spatial equations of motion of the rotor and field equations, as well as boundary conditions of the liquid, is established and solved, leading to a characteristic equation. First numerical results predict a wide range of rotor speeds, where the system performs unstable motions caused by a two-dimensional surface wave of the liquid. The stability boundaries are calculated for a flat rotor in dependence on the mass of the contained liquid and agree extremely well with experimental data.

82-1591

The Dynamics and Calculation of the Bearing of the Length with the Source of Viscous-Plastic Lubrication

K. Akhverdiyev

Rostovskii institut inzhenerov zheleznodorozhnogo transporta, USSR, Vibrotechnika, 2 (36), pp 81-89 (1981) 3 figs, 4 refs

(In Russian)

Key Words: Rotors, Bearings, Lubrication

Stabilized motion of unremovable viscous-plastic lubricant between the eccentric pin and the bearing is analyzed. The asymptotic solution of the problem was obtained by means of Genki-Ilyushin equation.

82-1592
Heat Exchange Between a Bearing with Viscous-Plastic Lubrication and a Shaft Vibrating at a Given Frequency
K. Akhverdiyev
Rostovskii institut inzhenerov zheleznodorozhnogo transporta, USSR, Vibrotechnika, 2 (36), pp 75-80 (1981) 3 figs, 2 refs
(In Russian)

Key Words: Shafts, Bearings, Heat transfer, Lubrication, Viscosity effects

Non-stabilized motion of the viscous-plastic bearing lubricant, caused by the exponential dependence of viscosity and yield point on temperature is investigated.

82-1593
Determination of Vibration Parameters of the Elements of a System "Flexible Shaft-Support"
R. Dashevskyj and A. Borisenko
Vibrotechnika, 2 (36), pp 131-137 (1981) 4 figs, 6 refs
(In Russian)

Key Words: Shafts, Rotors, Bearings, Vibration measurement

The vibrations of a shaft in the support region, the support itself and the relative vibrations of the shaft and the support were investigated. It is shown that for the evaluation of the vibration state of the system under investigation both the shaft and the support vibrations must be measured. To evaluate the stability of the sliding bearings relative vibrations must be measured.

82-1594
Wind-Tunnel Investigation of the Effects of Blade Tip Geometry on the Interaction of Torsional Loads and Performance for an Articulated Helicopter Rotor
W.T. Yeager and W.R. Mantay
NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TP-1926, AVRADCOM-TR-81-B-5, 64 pp (Dec 1981)
N82-13107

Key Words: Rotors, Blades, Geometric effects, Wind tunnel testing

The Langley transonic dynamics tunnel was used to determine the degree of correlation between rotor performance and the dynamic twist generated by changes in blade tip geometry using an articulated rotor with four different tip geometries at advance ratios of 0.20, 0.30 and 0.35.

82-1595
Comparison of the Unbalance Responses of Jeffcott Rotors with Shaft Bow and Shaft Runout
R.D. Flack, J.H. Rooke, J.R. Bielk, and E.J. Gunter
Dept. of Mech. and Aerospace Engrg., School of Engrg. and Appl. Sci., Univ. of Virginia, Charlottesville, VA 22901, J. Mech. Des., Trans. ASME, 104 (2), pp 318-328 (Apr 1982) 15 figs, 2 tables, 15 refs

Key Words: Rotors, Unbalanced mass response, Rotor bow, Shaft runout

The unbalance response of a Jeffcott rotor with shaft bow and/or runout was theoretically and experimentally studied. Bow refers to a rotor which is warped; bow is a function of running speed. Runout refers to electrical or mechanical asymmetrics of the shaft and is not dynamical. Included in the theoretical model is the capability of low-speed response compensation, such that the response at low speed can be vectorially subtracted from the total response at any rotational speed. Responses of rotors with equal amounts of bow or runout are shown to be significantly different in both Bode and Nyquist forms.

82-1596
Dynamics of Rigid Rotor in Resilient Mounting under the Influence of Disturbing Force with Elliptical Hodograph
E. Bogorod, A. Kelzon, A. Kuzmin, and A. Ščerbakov
Vibrotechnika, 2 (32), pp 89-95 (1981) 2 figs, 2 refs
(In Russian)

Key Words: Rotors, Rigid rotors, Natural frequencies

Rigid rotors under a special disturbing force were investigated to determine the nature of natural frequencies of rigid rotors. The study shows that symmetrical force produces natural frequencies of direct procession; but natural frequencies of inverse procession are produced by the assymetry of the disturbing force. The discovery enabled to derive formulas for the calculation of bearing pressure.

82-1597

Analysis of Drive Shaft Speed Variations in a Scotch Yoke Mechanism

J.L. Wiederrich

Central Engrg. Labs., FMC Corp., Santa Clara, CA 95052, J. Mech. Des., Trans. ASME, 104 (1), pp 239-246 (Jan 1982) 2 figs, 7 tables, 8 refs

Key Words: Shafts, Drive shafts, Scotch yoke mechanisms

Two analyses are presented for determining the drive shaft speed variations in a scotch yoke mechanism. The first analysis determines the speed variations when the mechanism is rigidly connected to a motor having a quadratic speed versus torque characteristic. The second analysis determines the speed variations when the mechanism is connected to a constant speed source through a flexible coupling. Together these models represent the two most common drive configurations. The results are of practical importance since they can be used in the preliminary calculations necessary in either the design of a main drive or the diagnosis of a drive problem in an existing machine.

82-1598

A Direct Integration Technique for the Transient Analysis of Rotating Shafts

F.H. Chu and W.D. Pilkey

RCA Astro, Princeton, NJ 08540, J. Mech. Des., Trans. ASME, 104 (2), pp 384-388 (Apr 1982) 2 figs, 12 refs

Key Words: Shafts, Transient response, Direct integration technique, Transfer matrix method

The continuous space discrete time Riccati transfer matrix method is a new direct integration technique for transient analysis of structural members. This method is applied to rotating shafts with bearing systems containing masses. Numerical results are given for a rotor with isotropic bearings.

82-1599

The Effects of an Annular Fluid on the Critical Speed of a Rotating Shaft

M.J. Guidez, Axisa, Gilbert, Girard, and Fardeau

Atomic Ctr. of Cadarache, Saint Paul Lez Durance, France, "Fluid-Structure Interactions in Turbomachinery," Winter Annual Meeting of the ASME, Washington, DC, Nov 15-20, 1981, W.E. Thompson, ed., pp 45-55, 9 figs, 8 refs

Key Words: Shafts, Critical speeds, Fluid-induced excitation, Computer programs, Interaction: structure-fluid, Turbomachinery

When a shaft is rotating in a dense fluid the effects of this fluid on the critical speed of the shaft cannot be neglected. After a brief review of the physical mechanism involved, a numerical code, ROTOR, is described which allows the calculation of these effects. Two loops are described with one and five meter shafts. It appears that the first test results agree with the ROTOR calculated values.

82-1600

Some Principles of Elastic Shaft Stability Including Variational Principles

R.C. Shieh

MRJ, Inc., 10400 Eaton Pl., Suite 300, Fairfax, VA 22030, J. Appl. Mech., Trans. ASME, 49 (1), pp 191-202 (Mar 1982) 3 figs, 9 tables, 10 refs

Key Words: Shafts, Axial excitation, Follower forces, Flutter

Flutter instability problems of a rotating circular elastic shaft subjected to both follower end torque(s) and dead force, and a rotating elliptical elastic shaft subjected to axial compressive dead force are studied, and some instability and variational principles are established in an "equivalent energy" term.

82-1601

Parametric Excitations of the Machine Drives

I. Vulfson

Leningradskii institut tekstilnoi i legkoi promishlennostic im. C.M. Kirova, USSR, Vibrotechnika, 1 (31), pp 63-70 (1981) 2 figs, 5 refs

(In Russian)

Key Words: Shafts, Machine drives, Par ... excitation

A dynamic model for a drive system is investigated. The drive system consists of a main shaft and a number of branches representing connecting and actuating mechanisms. The main shaft is represented as a twisting subsystem with distributed parameters; the branches -- a system with discrete parameters. Methods for the calculation of correction circuits are presented which enable to achieve a quasi-stationary condition of the system by controlling the appropriate parametric excitation.

82-1602

Analysis of the Vibration Engine's Dynamics with Ring Dipole

L. Patašiene and K. Ragulskis

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (31), pp 19-21 (1981) 2 refs (In Russian)

Key Words: Engines, Vibrating structures

Vibration engine with ring dipole is investigated. Equations for the analysis of the performance of engines are presented.

82-1603

Analysis and Identification of Subsynchronous Vibration for a High Pressure Parallel Flow Centrifugal Compressor

R.G. Kirk, J.C. Nicholas, G.H. Donald, and R.C. Murphy

Ingersoll-Rand Co., Phillipsburg, NJ 08865, J. Mech. Des., Trans. ASME, 104 (2), pp 375-383 (Apr 1982) 22 figs, 2 tables, 20 refs

Key Words: Compressors, Centrifugal compressors, Turbomachinery, Subsynchronous vibration

The evaluation of turbomachinery designs prior to actual hardware test and field installation is now the rule rather than the exception for rotating machinery manufacturers. This requires the verification of the current state of the art analytical techniques for rotor-bearing-seal dynamics by development testing and/or controlled test stand or field vibration studies. This paper presents the summary of a complete analytical design evaluation of an existing parallel flow compressor and reviews a recent field vibration problem that manifested itself as a subsynchronous vibration that tracked at approximately 2/3 of compressor speed. The comparison of predicted and observed peak response speeds, frequency spectrum content, and the performance of the bearing-seal systems are presented as the events of the field problem are reviewed. Conclusions and recommendations are made based upon the results of this design review.

82-1604

Experimental Study of Fluid Forces on Whirling Centrifugal Impeller in Vaneless Diffuser

H. Ohashi, H. Shoji, S. Yanagisawa, and K. Tomita

Univ. of Tokyo, Tokyo, Japan, "Fluid-Structure Interactions in Turbomachinery," Winter Annual Meeting of the ASME, Washington, DC, Nov 15-20, 1981, W.E. Thompson, ed., pp 57-62, 10 figs, 2 tables, 8 refs

Key Words: Centrifugal pumps, Impellers, Whirling, Viscous damping, Interaction: structure-fluid, Turbomachinery

Fluid forces on a rotating centrifugal impeller in whirling motion were studied experimentally. The test was limited to the cases in which a two-dimensional impeller surrounded by an unbounded vaneless diffuser whirls on a circular orbit with various positive and negative angular velocities. The results showed that the fluid forces exert a damping effect on the rotor whirl in most practically significant cases. Calculations were also conducted for pumps with the same geometry and whirl condition as those in the experiment for shock-free entry conditions. Quantitative agreement was obtained for the tangential component of fluid forces in positive whirl, but other quantities could be predicted only qualitatively.

82-1605

A New Approach to Pump Flange Loading

P.E. Simmons

Shell U.K. Exploration and Production, London, UK, Hydrocarbon Processing, 61 (3), pp 150-154 (Mar 1982) 2 figs, 1 ref

Key Words: Pumps, Flanges, Design techniques

A more logical approach to pump flange loading based on pump duty instead of just weight and flange size is proposed. With this method, piping design is simplified and pump reliability is enhanced.

82-1606
Measurement of Aerodynamic Work During Fan Flutter
A.P. Kurkov
NASA Lewis Res. Ctr., Cleveland, OH, "Fluid-Structure Interactions in Turbomachinery," Winter Annual Meeting of the ASME, Washington, DC, Nov 15-20, 1981, W.E. Thompson, ed., pp 9-18, 14 figs, 2 tables, 12 refs

Key Words: Fans, Flutter, Turbofan engines, Interaction: structure-fluid, Turbomachinery

Stationary high-response pressure and displacement measurements are used to describe the flutter characteristics of the first fan-rotor of a turbofan engine. Flutter occurred at part speed and at high incidence. Several forward and backward traveling waves were identified in a predominantly torsional flutter mode. Positive aerodynamic work contribution was confined to the region close to the leading edge and was mainly due to modes corresponding to forward traveling waves of nodal diameters in the range 3 to 5.

RECIPROCATING MACHINES

82-1607
Reducing Pulsation and Shock in Hydraulic Systems
S.S. Skaistis and D.L. Royston
Science Labs., Sperry Vickers, Troy, MI, Mach. Des., pp 77-79 (Mar 25, 1982)

Key Words: Pumps, Hydraulic systems, Noise reduction, Design techniques

Design techniques for eliminating, or at least greatly reducing, the noise or erratic operation of hydraulic systems caused by pulsation and shock are described.

82-1608
A Model of Piston Impact and Vibration for Internal Combustion Engine Noise Reduction
A.F. Seybert
Dept. of Mech. Engrg., Univ. of Kentucky, Lexington, KY 40506, Arch. Acoust., 6 (2), pp 89-110 (1981) 2 figs, 2 tables, 10 refs

Key Words: Diesel engines, Internal combustion engines, Cylinders, Linings, Pistons

A mathematical model is developed to study piston impact and cylinder liner vibration in internal combustion engines. The aim of this study is to assess the effect on cylinder liner response (and, therefore on piston-impact induced noise) of certain design modifications such as cylinder liner stiffness, piston mass, and piston/cylinder liner running clearance. A single-mode representation of cylinder liner vibration is developed using the assumed modes method, where the cylinder liner is modeled as a thin cylindrical shell with fixed-free boundary conditions. Expressions for the kinetic and potential energy of the system, and for the generalized mass and stiffness of the system are developed. Lagrange's equation of motion is used to derive a differential equation of cylinder liner motion.

POWER TRANSMISSION SYSTEMS

82-1609
Resonant Vibrating Platform Drive Unit with Hydraulic Clutch
I. Vishnevetskij and N. Grigorova
Kharkovski inzhenerno-stroitelnii institut, Vibrotechnika, 2 (36), pp 163-168 (1981) 2 figs, 2 refs
(In Russian)

Key Words: Power transmission systems, Fluid drives

Specification requirements for a resonant vibrating platform drive unit are formulated. A test model of an adjustable drive unit of the vibrating platform is built and tested.

METAL WORKING AND FORMING
(Also see No. 1814)

82-1610
Prediction of Linear Noise-Load Relationship for Impact Forming Machines
S. Vajpayee, M.M. Sadek, and S.A. Tobias
Dept. of Mech. Engrg., Univ. of Birmingham, P.O. Box 363, Birmingham, B15 2TT, UK, Intl. J. Mach. Tool Des. Res., 22 (1), pp 1-6 (1982) 4 figs, 1 table, 5 refs

Key Words: Hammers, Machining, Noise generation, Noise prediction

Noise emitted during hot forming on a high-energy-rate-forming (HERF) machine bears a linear relationship with the magnitude of the forming load. The existence of this linear correlation has been confirmed for a drop hammer, though the slope and the intercept of the noise-load line differed from the HERF case. It appears that for every hammer this noise-load relationship can be expected to be unique and independent of the process variables; i.e., input energy, billet size and properties, etc. A linear noise emission vs forming load variation, independent of the process variables, with a unique gradient and intercept for each hammer, could be used as a measure of the overall acoustic quality of the hammer structure. Such a criterion might prove in certain cases to be more meaningful than the conventional sound power criterion, especially when the prime concern is the avoidance of the operator's hearing damage. Furthermore, such a criterion would be easier to apply than that of the sound power. The present paper contains a theoretical analysis furnishing an explanation of the observed linear noise-load variation.

82-1611

Process Control for Increasing Accuracy at Machine Tools (Prozessregelung zur Genauigkeitssteigerung an Werkzeugmaschinen)

V. Goruschkin and H.G. Piegert
VEB Werkzeugmaschinenkombinat, "Fritz Heckert" Karl-Marx-Stadt, East Germany, Maschinenbautechnik, 31 (2), pp 55-58 (1982) 6 figs, 6 refs
(In German)

Key Words: Machine tools, Vibration control

Adaptive controls improve machining accuracy, rate of utilization and vibration stability of machine tools. It is shown that far more favorable effects can be attained with them than with expensive design measures which require high material inventory.

82-1612

Noise Reduction During the Production of Thick Walled Steel Constructions by Means of Impact Processing Techniques

B. Dupuis
Inst. f. Messtechnik im Maschinenbau, Technische Univ., Hanover, Fed. Rep. Germany, Rept. No. BMFT-FB-HA-81-008, 84 pp (June 1981)
N82-15851
(In German)

Key Words: Metal working, Steel, Noise generation, Noise reduction

A number of measures are described that can be taken to reduce the noise generated by techniques using impactors in the production of thick walled steel constructions. Suggestions, based on laboratory tests, are made for noise reduction by modification of the manufacturing procedure, by adaptation of the tools, and by diminishing the excitation and emission characteristics of the body under construction. By means of specific examples of container and steelframe construction, it is demonstrated that noise generated by impact processes can indeed be reduced to a large extent.

MATERIALS HANDLING EQUIPMENT

(Also see No. 1682)

82-1613

Some Properties of Vibrator Development with Compressed Gas Lubrication

R.M. Kanapenas
Kauno polytechnikos institutos, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (32), pp 39-48 (1981) 7 figs
(In Russian)

Key Words: Vibrators (machinery), Gas bearings, Stiffener effects

The development of compressed gas-lubricated vibrators and the determination of amplitude-frequency characteristics at different rigidities of the film is discussed. The dynamic model of a vibrosupport with stationary and alternating rigidities is analyzed. The methodology for the estimation of a compressed gas film in different directions is presented. The factors bringing about leading away moments in the vibrators and the possibility of their elimination are determined, and the means for their prevention are suggested.

82-1614

Selection of Mass Ratio in Two-Mass Vibration Machines

A. Borshchevsky
Moskovskii ordena Trudovo Krasnogo Znameni inzhenerno-stroitelnii institut im. V.V. Kuibisheva, USSR, Vibrotechnika, 2 (32), pp 7-15 (1981) 5 figs
(In Russian)

Key Words: Vibrators (machinery), Two-mass systems

Two-mass vibration machines with a centrifugal oscillation drive were investigated. Rational values of reaction and active mass relations were evaluated by installation of a vibrator on various masses.

82-1615
Acoustic System for Material Transport
M.B. Barmatz, E. Trinh, T.G. Wang, D.D. Ellman, and N. Jacobi
Pasadena Office, NASA, Pasadena, CA, PAT-APPL-6-314 929, 17 pp (Oct 26, 1981)

Key Words: Materials handling equipment, Conveyors, Acoustic techniques

An object within a chamber is acoustically moved by applying wavelengths of different modes to the chamber to move the object between pressure wells formed by the modes. In one system, the object is placed in one end of the chamber while a resonant mode, applied along the length of the chamber, produces a pressure well at the location. The frequency is then switched to a second mode that produces a pressure well at the center of the chamber, to draw the object. When the object reaches the second pressure well and is still traveling towards the second end of the chamber, the acoustic frequency is again shifted to a third mode (which may equal the first mode) that has a pressure well in the second end portion of the chamber, to draw the object. A heat source may be located near the second end of the chamber to heat the sample, and after the sample is heated it can be cooled by moving it in a corresponding manner back to the first end of the chamber. The transducers for levitating and moving the object may be all located at the cool first end of the chamber.

82-1616
Dynamics of the Vibrating Double-Coordinated Scanning Table
V. Gamziukas, K. Ragulskis, R. Kurilo, and R. Šatkus
Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (32), pp 49-56 (1981) 5 figs, 3 refs
(In Russian)

Key Words: Vibrators (machinery), Vibrating structures, Resonant response, High frequencies

A mathematical model and an analysis of a vibrating double-coordinated scanning table is presented. The operation of the scanning table is based on the effect of high frequency oscillation of resonant vibrators. Expressions for pitch shifting in the pitch regime of the movement and for pitch error were obtained. The basic characteristics of the device and main causes for pitch movement error are given.

82-1617
Vibration Transporting of Particles, Suspended in Liquid, by Means of High-Frequency Wave Oscillations
V. Milukiene and K. Ragulskis
Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (31), pp 79-84 (1981) 10 figs, 3 refs
(In Russian)

Key Words: Vibrators (machinery), Oscillating conveyors, High frequencies

Migration dynamics of the material particles along the duct, in the walls of which high-frequency harmonical travelling waves are generated, is studied.

STRUCTURAL SYSTEMS

BRIDGES
(See Nos. 1841, 1842)

BUILDINGS
(Also see Nos. 1840, 1841, 1842)

82-1618
Damping Measurements of Tall Structures
G.T. Taoka
Dept. of Civil Engrg., Hawaii Univ. of Manoa, Honolulu, HI, Rept. No. NSF/RA-800613, 18 pp (1980) PB82-147836

Key Words: Towers, Buildings, Multistory buildings, Steel, Damping coefficients, System identification techniques, Correlation technique, Spectral energy distribution technique, Spectral moments method

Results of an investigation of damping measurements of five tall steel structures are presented. The structures include four buildings ranging in height from 103 to 170 meters, and a four-legged square tower of a total height of 333 meters. For each structure, ambient vibration records were mechanically digitized and analyzed by three system identification methods: the correlation method, the spectral moments method, and the power spectral density method. A trapezoidal filter was used to isolate individual modes before the records were subjected to analysis. Damping estimates were also obtained under forced vibration rotating shaker tests.

82-1619
Method of Assessing Costs of Noise Control Requirements in Multifamily Residential and Educational Buildings
S.F. Weber, F.F. Rudder, Jr., and M.J. Boehm
Natl. Engrg. Lab., Natl. Bureau of Standards, Washington, DC, Rept. No. NBSIR-81-2366, 120 pp (Dec 1981)
PB82-140047

Key Words: Buildings, Multistory buildings, Noise control

This report presents a methodology developed to measure the cost impacts of acoustical performance requirements for new buildings. The methodology can be applied to a wide range of noise control requirements. The cost items addressed by this methodology are expected changes in construction costs, the cost of acoustical testing to certify levels of performance, code administration costs, and energy savings due to modifications of the building envelope. The building components considered, which are those most commonly affected by noise control requirements, are doors, windows, interior walls, exterior walls, and floor/ceiling assemblies.

82-1620
Wind Loading and Response of a High-Rise Building
R.S. Mills and D. Williams
URS/John A. Blume and Assoc., San Francisco, CA, 16 pp, presented at the Conf. on the Dynamic Response of Structures, Atlanta, GA, Jan 14, 1981
CONF-810104

Key Words: Buildings, Multistory buildings, Wind-induced excitation, Measuring instruments

An ongoing investigation concerned with the measurement and analysis of full-scale wind effects on high-rise buildings is presented. An instrumentation system suitable for the measurement of wind loading and structural response has been implemented in a 16-story building. The use of a displacement measuring system consisting of a vertically aligned laser and a light-sensitive diode permits evaluation of quasi-static as well as fluctuating response. Experimental results from several wind storms are compared to a recent method for analytically predicting alongwind structural response.

82-1621
Building Configuration and Seismic Design: The Architecture of Earthquake Resistance
C. Arnold and R. Reitherman
Building Systems Development, Inc., San Mateo, CA, Rept. No. NSF/CEE-81064, 286 pp (May 1981)
PB82-158569

Key Words: Buildings, Seismic design, Earthquake resistant structures

A study was undertaken to determine how the architecture of a building affects it ability to withstand earthquakes and to provide information that will lead toward good practice in seismic design. Discussed are aspects of ground motion which are significant to building behavior. Provided are results of a survey of configuration decisions that affect the performance of buildings with a focus on the architectural aspects of configuration design. Configuration derivation, building type as it relates to seismic design, and seismic issues in the design process are examined.

82-1622
Coupled Walls in Earthquake-Resistant Buildings: Parametric Investigation and Design Procedure
M. Saatcioglu, A.T. Derecho, W.G. Corley, and R.A. Parmelee
Construction Tech. Labs., Portland Cement Assoc., Skokie, IL, Rept. No. NSF/CEE-81055, 136 pp (July 1981)
PB82-147901

Key Words: Buildings, Multistory buildings, Earthquake resistant structures, Parameter identification technique

This project developed and analyzed design information on the behavior of multi-story structures during earthquakes. Structural and ground motion parameters, their effects on dynamic response, the most significant parameters as design variables, and relationships among the design variables were examined. A computer program was used to investigate nonlinear response of coupled wall structures. The analytical modeling procedures used are given and the effects of structural parameters on dynamic inelastic response of coupled walls are discussed. Properties of structures with different mass for inertia are noted. General information is provided concerning earthquake resistant design and variables found to be significant in formulating a design procedure.

FOUNDATIONS
(Also see No. 1717)

82-1623
The Dynamic Lateral Response of Deep Foundations
D.R. Gle

Ph.D. Thesis, Univ. of Michigan, 293 pp (1981)
UM DA8204657

Key Words: Foundations, Pile foundations, Interaction: soil-structure, Stiffness coefficients, Damping coefficients

A field testing procedure was developed and the dynamic lateral response of eleven full-scale pipe piles was obtained experimentally. Steady-state vibration and plucking tests were conducted on piles embedded in both cohesive and granular soils at three separate sites. Two piles in cohesive soils were retested with either a conventional compacted granular soil or a cement-stabilized granular soil replacing the insitu surficial soil. Dynamic soil properties adjacent to the piles were determined by suitable field and laboratory testing techniques. The theoretical dynamic response was predicted using a two-degree-of-freedom analysis with stiffness and damping parameters obtained from the computer program, PILAY, developed by Novak and Aboul-Ella. The theoretical predictions for the dynamic response curves were compared with the observed field testing results.

82-1624

Effect of Tension Cutoff between the Soil and Foundation on Structural Response

R.L. Burris

Ph.D. Thesis, Univ. of Maryland, 154 pp (1981)
UM DA8205220

Key Words: Foundations, Interaction: soil-structure, Frequency domain method, Soils, Springs

Soil-structure interaction analyses typically consider the strain dependent nature of soil properties. This implies a solution within the frequency domain using frequency dependent soil springs. These springs, or equivalents, are just as effective in tension or compression. The ability to exert a tensile force between a structural foundation and a cohesionless soil is almost non-existent. As a result, the structural response will be affected. The objective of this dissertation is to assess the effect of soil tension cutoff between the structural foundation and soil on the structural response. A method for the inclusion of this tension cutoff in a finite element analysis was developed in this dissertation. This method was applied to a series of model variations to assess the effect of embedment and different backfill materials on the results. As a means of determining an answer, a finite element model was created and analyzed.

82-1625

Two-Dimensional Hybrid Modelling of Soil-Structure Interaction

T.-J. Tzong, S. Gupta, and J. Penzien

Earthquake Engrg. Res. Ctr., Univ. of California, Berkeley, CA, Rept. No. UCB/EERC-81/11, NSF/CEE-81042, 59 pp (Aug 1981)
PB82-142118

Key Words: Interaction: soil-structure, Mathematical models, Finite element technique, Impedance technique

A hybrid model formed by partitioning a soil-structure system into a near-field and a far-field has been successfully exploited in the analysis of three dimensional soil-structure interaction problems. The near field which consists of the structure and a finite region of soil around it is modeled by the finite element method. The far-field which accounts for the loss of energy due to stress waves travelling away from the foundation is modeled through continuous impedance functions. The main purpose of this investigation is to complement the previous research on three-dimensional hybrid modeling by employing the same technique to the two-dimensional case.

HARBORS AND DAMS

(See Nos. 1841, 1842)

ROADS AND TRACKS

82-1626

Dynamic Instability in Ice-Lifting from a Flat Road Surface through Penetration with a Sharp Blade

N.C. Huang

Dept. of Aerospace and Mech. Engrg., Univ. of Notre Dame, Notre Dame, IN 46556, J. Appl. Mech., Trans. ASME, 49 (1), pp 187-190 (Mar 1982) 5 figs, 2 refs

Key Words: Ice removal, Roads (pavements), Blades, Crack propagation, Energy balance technique

The problem of dynamic instability during ice-lifting from a flat surface through penetration of the interface by means of a sharp blade is examined. The blade is subjected to a horizontal impulsive load and a constant horizontal thrust, both applied suddenly and simultaneously. The principle of the balance of energy is used to analyze the deformation of the ice associated with the crack propagation along the interface. The motion of the blade is investigated by the numerical solution of a complex, nonlinear, initial value problem. It is found that under a given horizontal thrust, if the initial velocity of the blade is sufficiently small, the motion of the blade may stop. However, if the initial velocity of the blade is sufficiently large, the motion of the blade is always forward and the crack can propagate indefinitely along the interface.

CONSTRUCTION EQUIPMENT

82-1627

Experimental Investigation of Dynamic Characteristics of Vibrating Rollers in Mechanisms of Rolamite Type by Optical Methods

R.-V. Ulozas

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (31), pp 137-143 (1981) 4 figs, 2 refs

(In Russian)

Key Words: Compaction equipment, Vibrating structures, Optical methods

Two types of vibrating rollers in the rolamite mechanism are investigated by optical methods. Two optical measuring instruments are discussed. The results of experimental investigation of dynamic characteristics of vibrating rollers of rolamite mechanisms are presented.

82-1628

The Possibilities of Operating the Friction Process in the Rolamite Mechanisms

R.-V. Ulozas

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (32), pp 119-127 (1981) 9 figs, 12 refs

(In Russian)

Key Words: Rollers (compaction equipment), Vibratory techniques

Some designs and the operation of rolamite mechanisms with vibratory rollers are considered, including the possibilities of friction process. The experimental procedure, data, and data analysis are given.

82-1629

Theoretical and Experimental Investigations on Vibratory Rollers with Waveguides in Rolamite Mechanisms

P. Vasiljev, J. Savitskas, and R.V. Ulozas

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (32), pp 129-136 (1981) 6 figs, 1 table, 12 refs

(In Russian)

Key Words: Rollers (compaction equipment), Vibratory techniques, Waveguide analysis, Runge-Kutta method

The use of waveguides with vibratory rollers in the rolamite mechanism is investigated. The Runge-Kutta method is used for the calculation of variable cross section disk waveguides. Approximate formulas for the calculation of waveguides were obtained by the method of interpolation curves. An experimental investigation performed on the system is also described.

82-1630

Proposed Test Plan for Studying the Impact of Construction Noise on Neighboring Communities

S.D. Hottman

Army Construction Engrg. Res. Lab., Champaign, IL, Rept. No. CERL-TR-N-115, 32 pp (Sept 1981)

AD-A108 768

Key Words: Construction industry, Noise generation, Noise measurement

This report presents a detailed test plan for studying the impact of noise from construction activities on neighboring communities The plan details the physical noise-measurement protocol, site selection plans, attitudinal questionnaires for residential and nonresidential areas, respondent sampling plans, and equipment and personnel needs.

82-1631

Highway Construction Noise Field Measurements, Site 1:1-201 (California) (Appendix A)

W.R. Fuller and R. Brown

Wyle Labs./Wyle Res., Arlington, VA, Rept. No. EPA-550/9-81-314-D, 52 pp (Oct 1981)

PB82-148149

Key Words: Construction industry, Noise measurement, Noise control

The noise associated with highway construction activities is investigated. It involves the identification and examination of highway construction activities, noise characteristics associated with highway construction activities, availability of highway construction noise abatement measures, demonstration of construction site noise abatement measures, and development of a computer-based model for use as a tool to predict the noise impact of construction activities and to plan mitigation measures. This report contains field data gathered at the field demonstrations at a highway construction site on Route I-201, California.

82-1632

Investigation of Work Regularity for Vibrating Doublejaw Crushers on "ABM" and Test Benches

I. Goncharevitch and B. Drigant

Ordena Oktyabrskoi revolyutsii i Ordena Trudovogo Krasnogo Znameni institut gornogo dela im. A.A. Skochinskogo, USSR, Vibrotechnika, 2 (36), pp 31-38 (1981) 3 figs

(In Russian)

Key Words: Construction equipment, Vibrators (machinery), Rocks

The characteristics of vibrating double-jaw crushers are described. During crushing, the vibroimpact may change the main parameters of the machine. Therefore, a system of equations, describing the interaction between a piece of crushed rock with crushing jaws and rock in bunker is proposed. Some results of rocks crushing in BDM-2 crusher with 150 x 300 mm in inlet size and 50 mm in width of exit slit and modeling of work process on an analogue computer EMU-10 are given.

82-1633

Highway Construction Noise Field Measurements, Site 2: I-205 (Oregon) (Appendix B)

W.R. Fuller and R. Brown

Wyle Labs./Wyle Res., Arlington, VA, Rept. No. EPA-550/9-81-314-E, 106 pp (Oct 1981)

PB82-148156

Key Words: Construction industry, Roads (pavements), Noise measurement, Experimental test data

This report contains field data gathered at the field demonstrations at highway construction sites in I-205, Oregon.

82-1634

A Model for the Prediction of Highway Construction Noise

K.J. Plotkin

Wyle Labs./Wyle Res., Arlington, VA, Rept. No. WR-80-58, EPA-550/9-81-314-B, 123 pp (Oct 1981)

PB82-148123

Key Words: Construction industry, Roads (pavements), Noise prediction, Mathematical models

This study investigated the noise associated with highway construction activities. It involved the identification and examination of: highway construction activities, noise characteristics associated with highway construction activities, availability of highway construction noise abatement measures, demonstration of construction site noise abatement measures, and development of a computer-based model for use as a tool to predict the noise impact of construction activities and to plan mitigation measures. This report (Part B) presents a complete description of the highway noise prediction model. The report contains a description of the model's formulation and construction, a description of the program, and a user's manual.

82-1635

IBM 360/System Batch Version of Highway Construction Noise Model

K.J. Plotkin

Wyle Labs./Wyle Res., Arlington, VA, Rept. No. WR-81-22, EPA-550/9-81-314-C, 39 pp (Oct 1981)

PB82-148131

Key Words: Construction industry, Roads (pavements), Noise prediction, Noise reduction, Computer programs

The noise associated with highway construction activities is investigated. It involves the identification and examination of highway construction activities, noise characteristics associated with highway construction activities, availability of highway construction noise abatement measures, demonstration of construction site noise abatement measures, and development of a computer-based model for use as a tool to predict the noise impact of construction activities and to plan mitigation measures. This report provides additional information to the Part B report on the highway construction noise model installed at DOT's Transportation Computer Center on an IBM 360 computer. It delineates the differences between the version of the model as installed on the IBM 360 and the two models (HINPUT and HICNOM) operating on the Wyle Computer (PDP-11). The report has additional user's manual information for use on the IBM 360, a programmer's manual describing changes in going from the PDP-11 to the IBM 360, and a maintenance manual.

82-1636

Analysis and Abatement of Highway Construction Noise

W.R. Fuller and R. Brown
Wyle Labs./Wyle Res., Arlington, VA, Rept. No. WR-81-19, EPA-550/9-81-314-A, 118 pp (Oct 1981)
PB82-148115

Key Words: Construction industry, Noise measurement, Noise control

This study investigated the noise associated with highway construction activities. It involved the identification and examination of: highway construction activities, noise characteristics associated with highway construction activities, availability of highway construction noise abatement measures, demonstration of construction site noise abatement measures, and development of a computer-based model for use as a tool to predict the noise impact of construction activities and to plan mitigation measures. This report (Part A) contains all of the information from the engineering study phase of the project. It gives information on highway construction procedures, highway construction site noise characteristics, available abatement measures, and results from field demonstrations on noise abatement.

82-1637

Highway Construction Noise Field Measurements, Site 4:1-75 (Florida) (Appendix D)

W.R. Fuller and R. Brown
Wyle Labs./Wyle Res., Arlington, VA, Rept. No. EPA-550/9-81-314-G, 221 pp (Oct 1981)
PB82-148172

Key Words: Construction industry, Noise measurement, Noise control

The noise associated with highway construction activities is investigated. It involves the identification and examination of: highway construction activities, noise characteristics associated with highway construction activities, availability of highway construction noise abatement measures, demonstration of construction site noise abatement measures, and development of a computer-based model for use as a tool to predict the noise impact of construction activities and to plan mitigation measures. This report contains field data gathered at the field demonstrations at highway construction sites in I-75, Florida.

82-1638

Highway Construction Noise Field Measurements, Site 3:1-95/395 (Maryland) (Appendix C)

W.R. Fuller and R. Brown
Wyle Labs./Wyle Res., Arlington, VA, Rept. No. EPA-550/9-81-314-F, 166 pp (Oct 1981)
PB82-148164

Key Words: Construction industry, Noise measurement, Noise control

This study investigated the noise associated with highway construction activities. It involved the identification and examination of: highway construction activities, noise characteristics associated with highway construction activities, availability of highway construction noise abatement measures, demonstration of construction site noise abatement measures, and development of a computer-based model for use as a tool to predict the noise impact of construction activities and to plan mitigation measures. This report contains field data gathered at the field demonstrations at highway construction sites in I-95/I-395, Maryland.

POWER PLANTS

(Also see Nos. 1720, 1722, 1723, 1724, 1725, 1726, 1727, 1728, 1836, 1837, 1841, 1842)

82-1639

Preliminary Analysis of Response of Control Rod Guide Tube Assembly to Pressure Transients

M.K. Au-Yang
The Babcock and Wilcox Co., Lynchburg, VA, "Vibration in Power Plant Piping and Equipment," Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engineering, Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. R.C. Iotti and M.D. Bernstein, eds., pp 53-59, 12 figs, 4 refs

Key Words: Nuclear reactors, Loss-of-coolant accident, Shock waves, Acoustic scattering

The response of the control rod guide tube assembly of a pressurized water nuclear reactor to the pressure transient caused by a reactor vessel outlet pipe break loss-of-coolant accident is computed by two methods. The first approximates the depressurization process by a series of weak shock waves. The second method approximates the process by acoustic wave scattering. Results computed by the two methods agree closely. In addition to giving a rough estimate of the response amplitude, these results serve as benchmarks against which detailed analyses using large general purpose computer codes can be compared.

OFF-SHORE STRUCTURES

82-1640

The Dynamics of Tension Leg Platforms in Waves

T. Yoneya and K. Yoshida

Technical Res. Lab., Nippon Kaiji Kyokai, Shinkawa, Mitaka-shi, Tokyo, Japan, J. Energy Resources Tech., Trans. ASME, 104 (1), pp 20-28 (Mar 1982) 9 figs, 3 tables, 34 refs

Key Words: Drilling platforms, Offshore structures, Wave forces, Statistical analysis

The dynamic response characteristics of the taut-moored platform or the so-called tension leg platform in regular waves are studied both by several series of tank tests and by some simplified methods of linear and nonlinear analyses. By comparison of the results it is shown that the analytical methods are valid and practical. In this paper the nonlinear responses observed in the model tests, as well as the characteristics of the linear frequency responses, are discussed in detail and clarified. In addition, statistical analysis is carried out on a full-scale TLP model in a real sea state.

82-1641

An Assessment of Linear Spectral Analysis Method for Offshore Structures via Random Sea Simulation

S. Kao

Mobil Res. and Dev. Corp., Dallas, TX 75221, J. Energy Resources Tech., Trans. ASME, 104 (1), pp 39-46 (Mar 1982) 9 figs, 1 table, 12 refs

Key Words: Offshore structures, Spectrum analysis, Simulation, Random excitation, Wave forces

With random sea simulation, application of linear spectral analysis method to offshore structures with moderate drag force has been assessed. Findings indicate overprediction of response for short natural periods and underprediction for very long periods. Tentative corrective measures are recommended. Significant force and response reductions have been calculated for flexible structures which are not adequately predicted by the linear spectral method.

82-1642

The Determination of Modal Damping Ratios from Maximum Entropy Spectral Estimates

R.B. Campbell and J.K. Vandiver

Exxon Production Res. Co., Houston, TX 77001, J. Dyn. Syst., Meas. and Control, Trans. ASME, 104 (1), pp 78-85 (Mar 1982) 7 figs, 1 table, 8 refs

Key Words: Offshore structures, Wind-induced excitation, Wave forces, Natural frequencies, Modal damping, Maximum entropy method

This paper focuses on the estimation of natural frequencies and modal damping ratios from measured response spectra, with particular emphasis on the dynamic response of offshore structures to wind and wave excitation. At present, estimates of natural frequencies and damping ratios are computed from the location and half-power bandwidths of resonant peaks in a structure's ambient response power spectrum. While reliable natural frequency estimates are typically obtained in this manner, half-power bandwidth damping estimates are shown to be highly sensitive to the method employed in estimating the response spectrum. The lack of confidence bounds on natural frequency and damping estimates further restricts the utility of the estimates. An alternative method is developed based on a powerful method of spectral estimation known as the Maximum Entropy Method (MEM). The resulting technique yields estimates of natural frequencies and modal damping ratios as well as approximate statistics on the reliability of the estimates. Performance of this new method is explored through extensive Monte Carlo simulation of one and two degree-of-freedom systems. Conventional estimates are also simulated for comparison with the MEM parameter estimator. The MEM parameter estimates show excellent agreement with natural frequency and damping estimates obtained during recent tests conducted using forced excitation.

82-1643

The Inertial Pressure Concept for Determining the Wave Forces on Submerged Bodies

T.E. Horton and M.J. Feifarek

Dept. of Mech. Engrg., Univ. of Mississippi, University, MS 38677, J. Energy Resources Tech., Trans. ASME, 104 (1), pp 47-52 (Mar 1982) 4 figs, 7 refs

Key Words: Offshore structures, Wave forces, Submerged structures

A new concept is presented which is aimed at improving the methodology for determining the wave forces on offshore structures. The Inertial Pressure Concept is based on a direct, empirical approach to calculating forces. The resulting method can be formulated to include realistic sea state wave kinematics while not being dependent on a particular kinematic representation. The method should be as easy to apply as the Morison equation, but will allow diffraction and three-dimensional aspects to be considered.

82-1644

Some Recent Studies of Vortex Shedding with Application to Marine Tubulars and Risers

O.M. Griffin and S.E. Ramberg

Marine Tech. Div., Naval Res. Lab., Washington, DC 20375, J. Energy Resources Tech., Trans. ASME, 104 (1), pp 2-13 (Mar 1982) 13 figs, 3 tables, 48 refs

Key Words: Marine risers, Vortex shedding, Vortex-induced excitation

Many types of marine structures are susceptible to vortex-excited oscillations. These include the risers and conductor tubes that are employed in offshore drilling and production, deep water pipelines, and members of jacketed structures. Deepwater pile installation and driving operations also have been hampered by problems arising from vortex shedding. A discussion is given in this paper of the problems caused by vortex shedding from flexible, bluff cylinders in steady current flows. In particular, recent measurements of the steady and unsteady deflections caused by the vortex-excited drag and lift forces are discussed. Various approaches that have been developed for the suppression of vortex-excited oscillations are reviewed. A classification and a comparison are made of the effectiveness of several suppression devices, and some practical examples of their application are presented.

82-1645

Dynamic Analysis of Marine Risers with Vortex Excitation

R.P. Nordgren

Shell Development Co., Houston, TX 77001, J. Energy Resources Tech., Trans. ASME, 104 (1), pp 14-19 (Mar 1982) 2 figs, 2 tables, 25 refs

Key Words: Marine risers, Vortex-induced excitation, Flexural vibration

The basic equations for nonplanar transverse vibrations of marine risers are derived from the theory of elastic rods. A numerical method is developed for solution of the equations by time integration. Spatial discretization is accomplished by a hybrid finite element method. Vortex excitation is modeled by the coupled wake oscillator proposed by Iwan and Blevins. The vortex oscillator equations are integrated numerically in time along with the riser equations. By way of example, several typical riser problems are analyzed including forced vibration and vortex-induced vibration.

82-1646

Hydrodynamic Forces on a Marine Riser: A Velocity-Potential Method

J.S. Chung

Colorado School of Mines, Golden, CO 80401, J. Energy Resources Tech., Trans. ASME, 104 (1), pp 53-57 (Mar 1982) 2 figs, 1 table, 8 refs

Key Words: Marine risers, Wave forces, Hydrodynamic excitation

A linear equation is mathematically derived for hydrodynamic forces on a marine riser under effects of free surface and floating-vessel motion using a velocity-potential method. It accounts for inertia and wave damping forces, including the force caused by riser motion, and empirically includes the drag force caused by viscosity. The equation, when reduced to a simpler form, is basically identical to the semi-empirical Morison equation for the inertia and drag forces. Theoretical validity of the simpler equation and the Morison equation is discussed. Previously, practical, semi-empirical force equations on the riser have been suggested, ignoring the effects of the free surface and the wave damping. The equations in current practice are compared with the present simpler equation.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see No. 1339)

82-1647

Performance Analysis and Testing of a Conventional Three-Piece Freight Car Truck Retrofitted to Provide Axle Steering

P. Marcotte, W.N. Caldwell, and H.A. List

CN Rail Research, Montreal, Quebec, Canada H4T-1K2, J. Dyn. Syst., Meas. and Control, Trans. ASME, 104 (1), pp 93-99 (Mar 1982) 8 figs, 1 table, 17 refs

Key Words: Railroads, Freight cars, Hunting motion, Cornering effects, Elastomers

The paper reviews the performance analysis and test work carried out on a conventional three-piece freight car truck retrofitted with elastomeric elements and cast steel steering arms in order to provide axle steering on curves and improved dynamic stability at higher speeds. A general approach on truck design is presented concerning linear truck dynamic stability and linear/nonlinear steady-state curve negotiation. Results of comparative performance tests are given, including the measurement of interaxle stiffnesses and the measurement of forces and angles of attack in curves, for both the

conventional and the modified trucks. Comments are given on the economic impact that the retrofitted steering truck is expected to have on railway operations.

submersible may be estimated. A computer program was developed. Comparison between model experimental and theoretical data shows satisfactory agreement.

82-1648

Effect of Interrupted Flow on Traffic Noise

K.R. Agent and C.V. Zegeer
Kentucky Transportation Research Program, College of Engrg., Univ. of Kentucky, Lexington, KY 40506, Noise Control Engrg., 18 (2), pp 69-73 (Mar-Apr 1982) 2 figs, 5 tables, 8 refs

Key Words: Traffic noise, Noise measurement

The effect that interrupted traffic flow has on traffic noise is investigated. Interrupted flow occurs when traffic is interrupted by a traffic control device, such as a stop sign or traffic signal. The basic method of analysis consisted of comparing field data taken at intersections to determine if measured noise levels changed as a function of distance from the intersection. Results show that interrupted flow conditions do not cause an increase in the L_{10} or L_{eq} noise levels. Data taken before and after the installation of traffic signals showed that the addition of traffic signals do not significantly affect the average noise level.

SHIPS

82-1649

Analysis of Motions of a Semisubmersible in Sea Waves

F.Z. Sun
Marine Des. and Res., Inst. of China, Shanghai, China, J. Energy Resources Tech., Trans. ASME, 104 (1), pp 29-38 (Mar 1982) 13 figs, 1 table, 9 refs

Key Words: Submerged structures, Cylinders, Wave forces, Hydrodynamic excitation, Computer programs

The forces acting on a three-dimensional cylinder with arbitrary symmetrical cross section are derived taking into account viscous effect and applying linear-processing techniques. General expressions for the hydrodynamic forces, motion equation and its solution for a semisubmersible platform in regular waves are obtained. Based on linear theory of statistical analysis, it is proposed to employ the concept of equivalent wave height for the calculation of transfer functions with which both the short-term and long-term distribution and statistical characteristics of the motion of a semi-

82-1650

Noise Prediction on Ships

E. Szczerbicki and A. Szuwarzynski
Ship Research Inst., Technical Univ. of Gdańsk, 80-952 Gdańsk, ul. Majakowskiego 11/13, Poland, Arch. Acoust., 6 (2), pp 111-121 (1981) 2 figs, 2 tables, 10 refs

Key Words: Ships, Noise prediction, Statistical analysis

Results of the first stage of investigation aimed at the development of an effective method for predicting noise on ships are presented. A statistical method of multiple linear regression was used for data processing. Calculated and measured results were compared. It has been shown that statistical methods are valid for predicting noise in the accommodation in the superstructure of a ship.

AIRCRAFT

(Also see Nos. 1665, 1700, 1787, 1827, 1834, 1835)

82-1651

Active Flutter Suppression on an F-4F Aircraft

O. Sensburg, H. Hönlinger, T.E. Noll, and L.J. Huttsell
Messerschmitt-Bölkow-Blohm, West Germany, J. Aircraft, 19 (5), pp 354-359 (May 1982) 24 figs, 18 refs

Key Words: Aircraft, Active flutter control

Extensive research programs have been conducted to investigate the application of active flutter and mode control to achieve increased flutter margins. Such techniques are of special interest for airplanes that already have a full command and stability augmentation system together with fast responding control surface actuators and that carry heavy wing mounted stores. A flutter suppression system was installed on the F-4F, and this system was flight tested. The control law was found by applying optimal control theory, thus minimizing the control surface motion due to disturbances and providing the required stability margins. It was found that the dynamic properties of the wing-pylon-store system change considerably with vibration amplitude because of play and preload.

82-1652

An Analytical and Experimental Study of the Steady and Unsteady Airloads on a Wing with Oscillating Control Including a Streamlined Gap

W. Geissler

Deutsche Forschungs- und Versuchsanstalf f. Luftund Raumfahrt e.V., Goettingen, Fed. Rep. Germany,

Rept. No. DFVLR-FB-81-18, 52 pp (Feb 1981)

N82-13119

Key Words: Aircraft wings, Aerodynamic loads

A wing section with oscillation control was studied in a 3m low speed wind tunnel. In order to simulate a realistic configuration, the gap between wing and control surface was streamlined. A modified analytical surface singularity method, taking into account the exact boundary conditions and Bernoulli equation, was developed. With this method the problem is handled as an interference problem between two lifting bodies with two Kutta conditions. Local lift distributions obtained from both experiment and theory are compared for a variety of parameters.

82-1653

Effects of Aerodynamic Coupling on the Dynamics of Roll Aircraft

G. Sachs and W. Fohrer

Hochschule der Bundeswehr, Munich, Fed. Rep. Germany,

48 pp (Jan 1981)

N82-12070

(In German)

Key Words: Aircraft, Aerodynamic loads, Coupled response

The effects of coupling of longitudinal and lateral aerodynamic characteristics on the dynamics of aircraft roll were studied, using simplified relations and complete six-degree of freedom calculations. The aerodynamic coupling is caused by unsymmetric flow conditions resulting from sideslipping, where rolling moments due to angle of attack and pitching moments due to angle of sideslip, are of particular significance for the problem. It is shown that the attainable rate of roll is significantly influenced and that marked effects on stability are possible.

82-1654

Wind-Tunnel Study of the Flutter Characteristics of a Supercritical Wing

R. Houwink, A.N. Kraan, and R.J. Zwaan

Natl. Aerospace Lab., Amsterdam, The Netherlands,

J. Aircraft, 19 (5), pp 400-405 (May 1982) 11 figs, 5 refs

Key Words: Flutter, Aircraft wings, Wind tunnel testing

A wind-tunnel flutter test on a supercritical wing model is described. Objectives of the test were to investigate the transonic dip and to make comparisons with calculated flutter characteristics in which a quasi-three-dimensional transonic theory was used. The beginning of a transonic dip was measured and a satisfactory agreement with theory was found. An additional flutter instability in the bottom of the transonic dip was correlated with the loss of transition strip effectivity at low Reynolds numbers.

82-1655

Estimation Methods for the Determination of Dynamic Responses of Elastic Aircraft

S. Vogel

Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, Fed. Rep. Germany,

Rept. No. BMVG-FBWT-81-6, 123 pp (1981)

N82-15037

(In German)

Key Words: Aircraft, Wind-induced excitation

A method for establishing the dynamic response of an elastic aircraft structure to external excitation, such as random gusts or arbitrarily timed maneuver loads is presented. The solution is based on an analytic representation of the admittance functions by partical fractions. The time response frequency dependence of the aerodynamic forces induced by motion are approximated to allow analytical solutions which are shown to be as accurate, but more economical, than more elaborate numerical Fourier methods.

82-1656

Fracture and Fatigue Characterization of Aircraft Structural Materials under Biaxial Loading

D.L. Jones and J. Eftis

Dept. of Civil, Mech. and Environmental Engrg., George Washington Univ., Washington, DC,

Rept. No. AFOSR-TR-81-0856, 204 pp (Dec 1981)

AD-A109 054

Key Words: Aircraft, Structural elements, Fatigue life, Fracture properties

A general fracture mechanics analysis was performed to examine the influence of biaxial applied loads on the mechanical state of the body. The geometries examined were the single crack and two coplanar cracks with an arbitrary orientation and the cracked shear panel. It was found that the biaxial loads influenced all aspects of the mechanical state of the body, with the exception of the stress intensity factor for a crack oriented parallel to the biaxial load. The extent and nature of the biaxial effect on the crack-tip stress field, stress intensity factor, angle of initial crack extension, crack-tip displacements, elastic strain energy, fracture load and fatigue crack growth rates are all discussed. A biaxial test facility was developed and a considerable number of photoelastic, fracture toughness, and fatigue crack growth rate experiments were performed.

82-1657

Acoustic Measurements of F-16 Aircraft Operating in Hush House, NSN 4920-02-070-2721

V.R. Miller, G.A. Plzak, and J.M. Chinn

Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH, Rept. No. AFWAL-TM-81-FIBE, 110 pp (Sept 1981)

AD-A109 829

Key Words: Aircraft, Sonic fatigue, Experimental test data, Design techniques

The purpose of this test program was to measure the acoustic environment in the hush house facility located at Kelly Air Force Base, Texas, during operation of the F-16 aircraft to ensure that aircraft structural acoustic design limits were not exceeded. The acoustic measurements showed that no sonic fatigue problems are anticipated with the F-16 aircraft aft fuselage structure during operation in the hush house. The measured acoustic levels were less than those measured in an F-16 aircraft water-cooled hush house at Hill AFB, but were increased over that measured during ground runup. It was recommended that the acoustic loads measured in this program should be specified in the structural design criteria for aircraft which will be subjected to hush house operation or defining requirements for associated equipment.

82-1658

A Digital Simulation Program Describing the Motion of an Aircraft Undergoing Engine Failure During Its Takeoff Ground Roll

M.J. Miedlar

Aeronautical Systems Div., Wright-Patterson AFB, OH, Rept. No. ASD-TR-81-5030, 77 pp (Sept 1981)

AD-A108 420

Key Words: Aircraft, Computer programs, Digital simulation

This report presents a non-interactive MIMIC program developed to generate the time history of an aircraft undergoing an engine failure during its ground roll. The program calculates the forces and moments acting on the aircraft, and uses MIMIC's implicit integration routine to track its motion. The equations and assumptions used are presented and discussed. This report also lists the program and delineates its functions.

82-1659

System Identification Helicopter Parameters. Determination from Flight Tests, Phase 2. (Systemidentifizierung Drehfluegel Kennwertermittlung aus Flugmessungen (Phase 2))

M. Kloster and S. Attlfellner

Messerschmitt-Boelkow-Blohm GmbH, Munich, Fed. Rep. Germany, Rept. No. BMVG-FBWT-80-12, 92 pp (1980)

N82-13137

(In German)

Key Words: Helicopters, Parameter identification technique, System identification techniques

A parameter identification program for a hingeless rotor helicopter is considered. Flight conditions were selected with increasing instability; i.e., hover and level flight at maximum speed, with maximum weight and with a rearward center of gravity. A strap down system was chosen to provide the attitude feedback control necessary for proper identification. The control input signals were optimized for the unstabilized helicopter. Calculations in the time and frequency domains show that special distributions in the power spectrum of the input signals are needed for optimizing the closed loop system. The identified derivatives and the smoothened time histories from flight tests are compared with the identification results of linear and nonlinear simulations and of the quasistatic theory.

82-1660

Stochastic Control and Identification of Helicopter Dynamic Modes

J. Molusis and Y. Bar-shalom

Univ. of Connecticut, Storrs, CT, Rept. No. NASA-CR-165057, 35 pp (Dec 1981)

N82-15032

Key Words: Helicopters, Parameter identification technique, Stochastic processes

Simulations of ground resonance model with constant and periodic coefficient measurement models were made. The extended Kalman filters, as an identification method, and its convergence properties were reviewed. Free response data for identification of damping for ground resonance was used and the ground resonance parameter identification results for constant coefficient and periodic coefficient measurement models are presented.

The SEA theory was used to develop a theoretical model to predict the transmission loss through an aircraft window. This work mainly consisted of the writing of two computer programs. One program predicts the sound transmission through a plexiglass window (the case of a single partition). The other program applies to the case of a plexiglass window with a window shade added (the case of a double partition with an air gap). The sound transmission through a structure was measured in experimental studies using several different methods in order that the accuracy and complexity of all the methods could be compared. Measurements were conducted on the simple model of a fuselage (a cylindrical shell), on a real aircraft fuselage, and on stiffened panels.

82-1661

Estimate of the Impact of Noise from Jet Aircraft Air Carrier Operations

K. Eldred

Bolt, Beranek and Newman, Inc., Cambridge, MA, Rept. No. BBN-4237, EPA-550/9-81-325, 59 pp (Sept 1980)

PB82-161324

Key Words: Aircraft, Noise generation, Airports

This report contains an update and revision of the estimated noise impact of airport jet air carrier operations in the years 1975 and 2000. These estimates are based on the current takeoff flight procedures, the 1979 FAA fleet forecast, and current definitions of new technology aircraft. They do not assume additional regulatory actions, either in aircraft noise certification or in airport operations, nor do they assume additional noise control efforts on the part of individual airports. These results are based largely on the methodology and data contained in a prior study except for updating certain basic information in that study from 1975 to 1979 and revising a part of the methodology for estimating population impacted.

82-1662

A Study of Methods of Prediction and Measurement of the Transmission Sound through the Walls of Light Aircraft

B. Forssen, Y.S. Wang, and M.J. Crocker

School of Mech. Engrg., Purdue Univ., Lafayette, IN, Rept. No. NASA-CR-165040, REPT-2, 24 pp (Dec 1981)

N82-15848

Key Words: Aircraft noise, Noise measurement, Noise prediction

82-1663

The Impact and Future Direction of Aircraft Noise Certification

M.J.T. Smith

Rolls-Royce Ltd., P.O. Box 31, Derby DE2 8BJ, UK, Noise Control Engrg., 18 (2), pp 52-61 (Mar-Apr 1982) 17 figs, 17 refs

Key Words: Aircraft noise, Regulations

After a decade of aircraft noise legislation, there has been only a small improvement in airport noise exposure. This trend cannot be seen as responsive to public pressure for an improved noise climate, nor compatible with a worsening world energy situation. With growing emphasis on noise contours there is a fear among manufacturers and operators that the industry may be faced with a second, perhaps more powerful, airport certification process. Unless the existing certification process is to become redundant during the 1980's it must be made more useful in the process of defining contour areas. This can only happen by a process of adaptation of the carefully established system, so that secondary noise control measures around airports become unnecessary, and the operator and airport manager judge the real impact of a new aircraft within the designated route structure. This broad situation is reviewed and some suggestions for improving the certification process are offered.

MISSILES AND SPACECRAFT

82-1664

Dynamic Simulation through Analytic Extrapolation

L.E. Ericcson and J.P. Reding

Lockheed Missiles and Space Co., Inc., Sunnyvale, CA, J. Spacecraft, 19 (2), pp 160-166 (Mar-Apr 1982) 17 figs, 36 refs

Key Words: Missiles, Spacecraft, Simulation, Flight simulation

In spite of the rapid progress of computational fluid dynamics (CFD), the existing capability to predict full-scale missile dynamics is very limited. The main reason for this is the existing strong coupling between boundary-layer transition and vehicle motion which cannot be simulated by present CFD methods and can be obtained experimentally only in tests at the full-scale Reynolds number. The present paper describes the interactive use of theoretical and experimental techniques to provide the means to extrapolate analytically to full-scale flight conditions. This capability is especially needed in regard to elastic vehicle dynamics because of the difficulties inherent in performing dynamic simulation of an elastic vehicle in the high Reynolds number ground testing facilities presently becoming available.

BIOLOGICAL SYSTEMS

HUMAN

82-1665
Vibration Levels in Army Helicopters -- Measurement Recommendations and Data
J.C. Johnson and D.B. Priser
Army Aeromedical Res. Lab., Fort Rucker, AL, Rept. No. USAARL-81-5, 35 pp (Sept 1981)
AD-A108 131

Key Words: Helicopters, Helicopter vibration, Vibration measurement, Human response

Surveys on vibration levels found in currently fielded helicopters were used to prepare a comparative summary of vibration exposure levels at crew stations and of the test methods used to measure these levels. Sources of the literature reviewed included technical reports of the U.S. Government agencies and papers in open literature. Articles were reviewed based upon three criteria: quantitative description of vibration in currently fielded U.S. Army rotary winged aircraft; article contents are unclassified and available for publication in open literature; article describes human exposure levels of aircraft vibration.

82-1666
Modelling Methods of the Operator's Body, Subjected to Machines' and Mechanisms' Vibrations
K. Frolov
Institut mashinovedeniya im. akad. A.A. Blagonravova, Moskva, USSR, Vibrotechnika, 1 (31), pp 41-53 (1981) 11 figs, 12 refs
(In Russian)

Key Words: Machinery vibration, Human response

Vibrations of "man-engine" systems were studied in order to obtain a scientific basis for vibration protection and machinery vibration regulation.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see Nos. 1750, 1752, 1779)

82-1667
Using the Envelope of Resonance Peaks to Estimate Power Absorbed by a Finite Structure
R.J. Pinnington
Southampton Univ., UK, Rept. No. ISVR-TR-115, 40 pp (Mar 1981)
N82-15472

Key Words: Vibration absorption (materials), Measurement techniques, Resonant frequencies

An absorbed vibration power measuring method applicable when a structure is sufficiently lightly damped for the vibrations to be governed by modal behavior is presented. Power input to the structure is found by measuring the power absorbed by each vibrational mode which is calculated from the resonance peak value of the point, or transfer inertance at selected points and the acceleration spectra at these points, measured under normal operating conditions. Cubic spline curves fitted through the resonance peak inertance values estimate power levels between resonances. It is found that the method is accurate in resonance regions, but not in the troughs between resonances.

82-1668
New Options for Wave Springs
M. Greenhill

Smalley Steel Ring Co., Wheeling, IL, Mach. Des., pp 89-92 (Mar 25, 1982)

Key Words: Springs (elastic), Design techniques

The improvements in wave springs, which once were limited to small deflections, moderate loads, and inconsistent operating characteristics, are described. The improvements are achieved by the development of new configurations; i.e., parallel-stacked wave springs, tighter tolerances, and more durable materials.

82-1669

Accumulator Retracts Shock-Absorber Rod at Stroke End

E.J. Stefanides

Cahners Publishing Co., Inc., 221 Columbus Ave., Boston, MA 02116, Des. News, pp 87, 89-90 (Apr 5, 1982)

Key Words: Shock absorbers

Shock absorbers which stop objects that must be moved at 90 deg to original line of travel are described. These shock absorbers are evolved from an existing line of adjustable, hydraulic shock absorbers that combine adjustable capacity (or rate of energy absorption) with linear deceleration (at all rates). Within the device, this capability is achieved by using a cylinder (high-pressure tube) with orifices at various locations along its length, and installing this cylinder within a close-fitting slotted sleeve.

82-1670

Snubber Assembly

A.R. Dean

Dept. of the Navy, Washington, DC, PAT-APPL-6-211 981, 11 pp (Dec 1980)

Key Words: Snubbers, Shock absorbers

Electronic modules are protected from damage which might be caused by ambient vibrations and shock. Openings in the cabinet are sized to accommodate the electronic modules and snubbers are interposed between the modules and the walls of the cabinets to hold them securely in place. A pair of Belleville springs in each snubber force a projecting portion of a piston against the module or a flat strap that serve to distribute the snubbing force over a wider area on the module.

82-1671

Experimental and Analytical Studies of Advanced Air Cushion Landing Systems

E.G.S. Lee, A.B. Boghani, K.M. Captain, H.J. Rutishauser, and H.L. Farley

Foster-Miller Associates, Inc., Waltham, MA, Rept. No. NASA-CR-3476, 188 pp (Nov 1981)

N82-12065

Key Words: Air cushion landing systems

Several concepts are developed for air cushion landing systems (ACLS) which have the potential for improving performance characteristics (roll stiffness, heave damping, and trunk flutter), and reducing fabrication cost and complexity. After an initial screening, the following five concepts were evaluated in detail: damped trunk, filled trunk, compartmented trunk, segmented trunk, and roll feedback control. The evaluation was based on tests performed on scale models. An ACLS dynamic simulation developed earlier is updated so that it can be used to predict the performance of full-scale ACLS incorporating these refinements.

82-1672

Design for Active and Passive Flutter Suppression and Gust Alleviation

M. Karpel

Dept. of Aeronautics and Astronautics, Stanford Univ., CA, Rept. No. NASA-CR-3482, 117 pp (Nov 1981)

N82-13147

Key Words: Flutter, Active flutter control

Analytical design techniques for active and passive control of aeroelastic systems are based on a rational approximation of the unsteady aerodynamic loads in the entire Laplace domain which yields matrix equations of motion with constant coefficients. Some existing schemes are reviewed, the matrix Pade approximant is modified, and a technique which yields a minimal number of augmented states for a desired accuracy is presented. The state-space aeroelastic model is used to design an active control system for simultaneous flutter suppression and gust alleviation. The design target is for a continuous controller which transfers some measurements taken on the vehicle to a control command applied to a control surface. Structural modifications are formulated in a way which enables the treatment of passive flutter suppression system with the same procedures by which active control systems are designed.

BLADES

(Also see No. 1594)

82-1673

Dynamic Stability of a Rotor Blade Using Finite Element Analysis

N.T. Sivaneri and I. Chopra

Stanford Univ., Stanford, CA, AIAA J., 20 (5), pp 716-723 (May 1982) 7 figs, 4 tables, 16 refs

Key Words: Helicopters, Propeller blades, Blades, Aerodynamic loads, Flutter, Beams, Finite element technique

The aeroelastic stability of flap bending, lead-lag bending, and torsion of a helicopter rotor blade in hover is examined using a finite element formulation based on Hamilton's principle. Quasisteady two-dimensional airfoil theory is used to evaluate the aerodynamic loads. The rotor blade is discretized into beam elements, each with ten nodal degrees of freedom. The resulting nonlinear equations of motion are solved for steady-state blade deflections through an iterative procedure. The flutter solution is calculated assuming blade motion to be a small perturbation about the steady solution. The normal mode method based on the coupled rotating natural modes about the steady deflections is used to reduce the number of equations in the flutter eigenanalysis. Numerical results are presented for hingeless and articulated rotor blade configurations.

82-1674

Prediction of Aerodynamically Induced Vibrations in Turbomachinery Blading

D. Hoyniak and S. Fleeter

School of Mech. Engrg., Purdue Univ., West Lafayette, IN, "Fluid-Structure Interactions in Turbomachinery," Winter Annual Meeting of the ASME, Washington, DC, Nov. 15-20, 1981, W.E. Thompson, ed., pp 1-8, 12 figs, 14 refs

Key Words: Blades, Aerodynamic loads, Interaction: structure-fluid, Turbomachinery, Energy balance technique

To predict the aerodynamically forced response of an airfoil, an energy balance between the unsteady aerodynamic work and the energy dissipated through the airfoil structural and aerodynamic damping is performed. Theoretical zero incidence unsteady aerodynamic coefficients are then utilized in conjunction with this energy balance technique to predict the effects of reduced frequency, inlet Mach number, cascade geometry, and interblade phase angle on the torsion mode aerodynamically forced response of the cascade. In addition, experimental unsteady aerodynamic gust data for flat plate and cambered cascaded airfoils are used together with these theoretical cascade unsteady aerodynamic damping coefficients to indicate the effects of incidence angle and airfoil camber on the forced response of the airfoil cascade.

82-1675

Tangential Vibration of Integral Turbine-Blades Due to Partial Admission

K. Namura

Mech. Engrg. Res. Lab., Hitachi Ltd., Hitachi, Ibaraki, Japan, "Fluid-Structure Interactions in Turbomachinery," Winter Annual Meeting of the ASME, Washington, DC, Nov. 15-20, 1981, W.E. Thompson, ed., pp 25-32, 15 figs, 1 table, 9 refs

Key Words: Blades, Turbine blades, Vibration tests, Resonant response, Interaction: structure-fluid, Turbomachinery

The tangential vibration of blades, formed integrally with a rotor, is examined under full and partial admission conditions. Rotating vibration tests are conducted with a test turbine, and resonant stresses in the blades, due both to nozzle wake excitation and impulse excitation, are measured. A method to predict resonant stresses in the blades using a simplified exciting force analysis is demonstrated. Agreement between measured and calculated resonant stresses for a single blade is fairly good. It is found that the calculation method is useful for the understanding of vibration phenomena due to partial admission and for the evaluation of resonant stresses of blades during the preliminary design process.

82-1676

Potential Interaction between a Centrifugal Impeller and a Vaned Diffuser

T. Iino

Mech. Engrg. Res. Lab., Hitachi, Ltd., Kandatsumachi, Tsuchiura, Ibaraki, Japan, "Fluid-Structure Interactions in Turbomachinery," Winter Annual Meeting of the ASME, Washington, DC, Nov. 15-20, 1981, W.E. Thompson, ed., pp 63-69, 14 figs, 1 table, 4 refs

Key Words: Blades, Impellers, Fluid-induced excitation, Cyclic loading, Fatigue life, Interaction: structure-fluid, Turbomachinery

Analytical studies are conducted to investigate the dynamic load on centrifugal impeller blades caused by potential interaction between the impeller and a vaned diffuser. In order to simulate the unsteady flow due to such interaction, an analytical model is constructed based on the assumptions of two-dimensional potential flow and infinitely thin blades. The unsteady velocity field in the impeller induced by the vaned diffuser is analyzed using the singularity method. The unsteady pressure field is solved using the unsteady Bernoulli's equation for a rotating coordinate system. Unsteady flow quantities are expressed in the form of Fourier series. Numerical results are obtained for some sample configurations, and the effects of the configurations on the pressure fluctuation amplitude are examined.

BEARINGS

(Also see Nos. 1591, 1592, 1593)

82-1677

Optimum Journal Bearing Parameters for Minimum Rotor Unbalance Response in Synchronous Whirl

R.B. Bhat, J.S. Rao, and T.S. Sankar
Dept. of Mech. Engrg., Concordia Univ., Montreal, Quebec, Canada, J. Mech. Des., Trans. ASME, 104 (2), pp 339-344 (Apr 1982) 12 figs, 1 table, 12 refs

Key Words: Bearings, Hydrodynamic bearings, Optimum design, Unbalanced mass response, Whirling

Optimization techniques are employed to design hydrodynamic bearings for minimum unbalance response of rotors in synchronous whirl. The analysis for the unbalance response considers the effects of direct and cross coupled coefficients of stiffness and damping in the bearings. A parametric study of the unbalance response is carried out to show the influence of bearing parameters on the response and to demonstrate the merits of applying optimization techniques in bearing design. The bearing parameters optimized are the diameter, clearance, and the oil viscosity. In addition to setting upper and lower limits on the foregoing design variables, the Sommerfeld number is also constrained to be within a certain range for the operational speeds of the rotor. The quantity minimized is the maximum unbalance response of the rotor in the operational speed range. Plain cylindrical, grooved, elliptical, and four shoe tilting pad type bearings are considered in the optimal design of the rotor bearing system. The results indicate that an optimal design of hydrodynamic bearings can reduce the unbalance response of rotors.

82-1678

Finite Journal Bearing with Nonlinear Stiffness and Damping. Part 1: Improved Mathematical Models

E. Hashish, T.S. Sankar, and M.O.M. Osman
Dept. of Mech. Engrg., Concordia Univ., Montreal, Quebec, Canada, J. Mech. Des., Trans. ASME, 104 (2), pp 397-405 (Apr 1982) 13 figs, 1 table, 18 refs

Key Words: Bearings, Journal bearings, Nonlinear damping, Nonlinear stiffness, Mathematical models

Two mathematical models for the nonlinear hydrodynamic film forces in a finite bearing are developed including a practical adaptation of the cavitation phenomenon. Using the linearity of the Reynolds equation for incompressible film, the pressure components are effectively decomposed and the Reynolds equation is rearranged for general solution by a finite element program in which only the L/d ratio and the eccentricity ratio are to be specified. The different possibilities of partial film profile location in a general dynamic case are demonstrated. The two partial film models possess the required accuracy of the finite bearing approach with the simplicity of the known long and short bearing approximations which are shown as the upper and lower bounds for the present case. The finite bearing approach presented is particularly suitable for nonlinear dynamic analysis.

82-1679

Finite Journal Bearing with Nonlinear Stiffness and Damping. Part 2: Stability Analysis

E. Hashish, T.S. Sankar, and M.O.M. Osman
Dept. of Mech. Engrg., Concordia Univ., Montreal, Quebec, Canada, J. Mech. Des., Trans. ASME, 104 (2), pp 406-411 (Apr 1982) 8 figs, 1 table, 10 refs

Key Words: Bearings, Journal bearings, Nonlinear damping, Nonlinear stiffness, Stability

Stability analysis is performed on the linearized as well as the actual nonlinear finite bearing equations using the improved mathematical models for the hydrodynamic forces that are presented in Part 1 of this investigation. The results of the analysis using the linear equations show a significant trend, different from previous investigation, with respect to different L/d ratios and therefore can be considered as modified stability curves for the finite bearing. The nonlinear analysis, based on numerical integration of the equation of motion, is carried out for the commonly used L/d = 1. Details on the stability behavior of the finite bearing are established, including the orbital stability regions. It is also found that under certain light loading conditions, the supply pressure can introduce a high possibility of orbital stability to the system.

82-1680
On the Movement of Air Film in Radial Clearance of Belt-Type Air Bearing
A. Galinskas and V. Lukšytė
Kauno polytechnikos institutas, Kaunas Lithuanian SSR, Vibrotechnika, 2 (36), pp 95-98 (1981) 2 figs, 4 refs
(In Russian)

Key Words: Bearings, Gas bearings

Dynamic behavior of air films in belt-type air bearings was investigated. Differential equations describing the character of velocity distribution in the cross section of film were solved taking into account variable pressure. The existence of various layers in the film were found.

82-1681
The Investigation of Gas-Statical Support with Tape-Shaped Operational Clearances
A. Galinskas and J. Gaspariūnas
Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (36), pp 125-130 (1981) 7 figs, 2 refs
(In Russian)

Key Words: Bearings, Radial bearings, Gas bearings, Experimental test data

Static and dynamic characteristics of radial gas bearings with conical clearances were investigated experimentally. Methods of investigation and instrumentation are described. Experimental data are compared with theory.

BELTS
(See No. 1680)

GEARS
(See Nos. 1813, 1843, 1844)

COUPLINGS

82-1682
Non-Linear Elastic Coupling Effectiveness in Machine Assembly with Variable Reduced Moment of Inertia
M. Bart
Leningradskii politekhnicheskii institut im. M.I. Kalinina, USSR, Vibrotechnika, 2 (32), pp 107-117 (1981) 4 figs, 5 refs
(In Russian)

Key Words: Two-mass systems, Flexible couplings

The effect of a nonlinear elastic coupling on the dynamics of machine assembly is investigated. The machine is represented as a two-mass system, where moment of inertia of the drive mass depends on the angle of rotation. The action of some moment of resistance, which depends on the angle of rotation and speed of rotation of the driven mass, is also considered.

FASTENERS
(See Nos. 1782, 1783)

LINKAGES

82-1683
The Design of Central Crank-Rocker Mechanism of a Minimum Mass by Means of a Digital Computer
S. Stravinskas
Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (31), pp 103-109 (1981) 2 figs, 5 refs
(In Russian)

Key Words: Mechanisms, Design techniques

Optimum minimum mass parameters for members of central crank rocker mechanisms, based on strength and statistical stability, are obtained by means of a digital computer. The formulas for the determination of the length of the member are proposed.

VALVES
(See No. 1685)

SEALS

82-1684
Convergent-Tapered Annular Seals: Analysis for Rotordynamic Coefficients
D.W. Childs

Mech. Engrg. Dept., Texas A&M Univ., College Station, TX, "Fluid-Structure Interactions in Turbomachinery," Winter Annual Meeting of the ASME, Washington, DC, Nov. 15-20, 1981, W.E. Thompson, ed., pp 35-44, 7 figs, 14 refs

Key Words: Seals, Pumps, Dynamic properties, Interaction: structure-fluid, Turbomachinery

A combined analytical-computational method is developed to calculate the pressure field and dynamic coefficients for tapered high-pressure annular seals typical of neck-ring and interstage seals employed in multistage centrifugal pumps. Completely developed turbulent flow is assumed in both the circumferential and axial directions and is modeled by Hirs' bulk-flow turbulent-lubrication equations. Linear zeroth and first-order perturbation equations are developed for the momentum equations and continuity equations. The development of the circumferential velocity field is defined from the zeroth-order circumferential-momentum equation. A centered, axial-pressure-gradient relationship is defined from the zeroth-order axial-momentum equation. A short-bearing approximation is used to define the first-order axial velocity field from the first-order continuity equation. The result of these analyses is an analytical expression for the first-order (dynamic) pressure gradient. This expression is integrated numerically to define dynamic coefficients for the seal. Numerical results are presented and compared to previous results for straight and tapered seals.

82-1685

Dynamic Loads in Reciprocating Seals of Hydrosystem Valves

J. Dulevicius and S. Žiedelis

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (32), pp 143-150 (1981) 5 figs, 6 refs

(In Russian)

Key Words: Seals, Valves, Hydraulic seals

A relation between contact pressure and dynamic loads acting in reciprocating seals is given. Experimental data showing the effect of dynamic loads on the efficiency of reciprocating seals are presented.

CAMS

82-1686

The Sensitivity Analysis of Cam Mechanism Dynamics

S.-S.D. Young and T.E. Shoup

Harry J. Sweet and Assoc., Inc., Houston, TX, J. Mech. Des., Trans. ASME, 104 (2), pp 476-481 (Apr 1982) 4 figs, 6 tables, 11 refs

Key Words: Cams, Design techniques, Sensitivity analysis

In order to improve the dynamic performance of a cam mechanism, it is desired to have a method that does not require a trial-and-error procedure based on total system re-analysis or re-synthesis. In this paper a new sensitivity analysis method will be presented that allows the designer to make system modifications to move the design in the direction of the global optimum. To implement this method the output response of the system is first expressed in terms of the system eigendata. An efficient procedure for determining sensitivity of the system response to changes in individual system parameters is developed utilizing the eigenvalue and eigenvector derivatives with respect to the system design parameters. An example of a double level cam mechanism with a four-degree-of-freedom dynamic system model is used to illustrate the technique.

82-1687

On the Dynamic Behavior of Cam Mechanisms with Followers (Ein Beitrag zum dynamischen Verhalten der Kurvengetriebe mit Schwinghebel)

M. Gürgöze

Fakultät f. Maschinenbau (Macka), Technische Universität Istanbul, Istanbul, Turkey, Ing. Arch., 51 (5), pp 311-323 (1982) 6 figs, 16 refs

(In German)

Key Words: Cam followers, Lateral vibration

The followers in cam mechanisms are usually regarded as rigid elements in a dynamical analysis. In this work, cam mechanisms with oscillating followers were investigated. The follower was considered as a thin elastic rod and the other members of the mechanism were taken as rigid. After setting up the equation of lateral motion of the oscillating follower in the plane of the mechanism, the lateral vibrations were investigated from a stability point of view by reducing the differential equation to a Hill system. Using an approximate solution of the system obtained above, the effect of various parameters on the contact between the cam and its roller were analyzed. It was found that the consideration of the elasticity of the follower gave different results as compared to the analysis where it was assumed to be rigid. Thus the elasticity of the follower is an important parameter to be considered.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

82-1688

Explicit Solution of the Inverse Problem for a Vibrating String

V. Barcilon
Dept. of Geophysical Sciences, Univ. of Chicago, IL, 24 pp (Nov 1981)
AD-A108 133

Key Words: Strings, Vibrating structures

The problem of reconstructing the density rho(x) of a vibrating string of length L from the knowledge of two spectra (lambda n)1 to infinity and (microns n)1 to infinity is considered. The method of construction relies on a formula for rho at an arbitrary point x = l in terms of the spectra (lambda n (1))1 to infinity and (microns n (l))1 to infinity associated with the natural frequencies of vibration of the portion (l, L) of the original string, and on a set of first order differential equations for (lambda n(l))1 to infinity and (micron n (l))1 to infinity. The density is deduced by integrating these equations of the spectra and substituting in the above mentioned formula.

82-1689

The Fatigue of Structural Wire Strands

R.E. Hobbs and K. Ghavami
Dept. of Civil Engrg., Imperial College of Sci. and Tech., Imperial College Road, London SW7 2BU, UK, Intl. J. Fatigue, 4 (2), pp 69-72 (Apr 1982) 6 figs, 4 refs

Key Words: Wire, Fatigue life

This paper presents the results of a limited series of large scale in-line and bending fatigue tests on socketed structural strands typical of those used as stays for guyed masts and for suspension bridge hangers. The strand, consisting of a group of hard drawn galvanized steel wires laid up helically about a common axis, is terminated by zinc filled conical sockets. The various failure mechanisms, concentrated on the wires close to the socket, are described and discussed. It is concluded that conservative predictions of the in-line fatigue lives of real strands should be possible although further work is needed on bending fatigue.

82-1690

Component Lead Wire Strain Relief for Random Vibration Environments

V.M. Scardina
Litton Guidance and Control Systems, Woodland Hills, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meetings of the Institute of Envronmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 87-91, 6 figs

Key Words: Circuit boards, Random vibration, Fatigue life, Wire

Printed circuit boards exposed to severe random vibration environments for prolonged periods often experience fatigue failures. These failures are manifest in one of the following malfunctions: severed circuit traces, fractured solder joints, fretting corrosion of connector contact pins, or broken lead wires on electronic components. It is the latter occurrence that is the focus of this paper.

CABLES

82-1691

Large Deformation Static and Dynamic Finite Element Analysis of Extensible Cables

I. Fried
Dept. of Math., Boston Univ., Boston, MA 02215, Computers Struc., 15 (3), pp 315-319 (1982) 7 figs, 3 tables, 8 refs

Key Words: Cables, Finite element technique

Approximate numerical integration of the element total potential energy with polynomial interpolation of the displacements creates high order nonlinear, extensible, cable finite elements. Successful computations of static and dynamic large displacement cable problems are carried out with the element.

BARS AND RODS

82-1692

Acceleration Wave Propagation in Hyperelastic Rods of Variable Cross-Section

A. Jeffrey

Dept. of Engrg. Math., The Univ. of Newcastle upon Tyne, UK, Wave Motion, 4 (2), pp 173-180 (Apr 1982) 12 refs

Key Words: Rods, Variable cross section, Wave propagation

It is shown that when an acceleration wave propagates in a hyperelastic rod with slowly varying cross-section, the transport equation for the wave intensity is a generalized Riccati equation. The three coefficients in the equation all depend on the material properties, but only the coefficient of the quadratic term is independent of the effect of area change. Three theorems are proved, based on the use of comparison equations, which establish that in general the acceleration wave intensity will become infinite (escape) after the wave has propagated only a finite distance along the rod. The existence of thresholds for the initial intensity are also established in certain cases, with their most notable property being that as the initial intensity decreases towards the threshold, so the distance the wave propagates to escape increases without bound.

82-1693
Stress Wave Propagation in a Bar of Arbitrary Cross Section
K. Nagaya
Dept. of Mech. Engrg., Gunma Univ., Kiryu, Gunma, Japan, J. Appl. Mech., Trans. ASME, 49 (1), pp 157-164 (Mar 1982) 3 figs, 7 tables, 19 refs

Key Words: Bars, Wave propagation, Frequency equation, Longitudinal waves, Flexural waves, Torsional waves

In this paper a method for solving wave propagation problems of an infinite bar of arbitrary cross section is presented. The frequency equation for finding phase velocities for longitudinal, torsional, and flexural waves was obtained by making use of the Fourier expansion collocation method which was developed by the author on the vibration and dynamic response problems of membranes and plates. As a numerical example, the phase velocities versus wave numbers are calculated for elliptical and truncated elliptical cross-section bars.

BEAMS
(Also see Nos. 1673, 1728)

82-1694
The Influence of Support Compliances on the Vibration of Slightly Curved Beams (Vplyv poddajnosti podpier na kmitanie mierne zakrivených nosníkov)
T. Nánási and L. Půst
Inst. of Materials and Machine Mechanics of the Slovak Academy of Sciences, Bratislava, Czechoslovakia, Strojnicky Časopis, 33 (1), pp 49-70 (1982) 15 figs, 3 refs
(In Slovak)

Key Words: Beams, Curved beams, Supports, Stiffness effects, Natural frequencies, Mode shapes

The influence of support compliances on coupled bending-extensional vibration of a slightly curved beam is investigated. The beam is hinged on its ends, which are supported on elastic springs in both radial and tangential directions. Analytical and numerical solutions are presented. The occurrence of decoupled pure bending mode and coupled bending-extensional modes are analyzed by assessment of maximum strain energy contributions due to bending or extension. Representative results of numerical solutions are graphically presented. The variation of eigenfrequencies and mode shapes with changes of curvature, radial and tangential compliances of beam restraints is also discussed.

82-1695
Static and Dynamic Response of Helically Curved Thin-Walled Girders
R.A. Bauman
Ph.D. Thesis, Univ. of Illinois at Urbana-Champaign, 144 pp (1981)
UM DA8203401

Key Words: Girders, Beams, Curved beams, Geometric effects, Natural frequencies

This dissertation presents a finite element method of analysis for the static and dynamic response of helically curved thin-walled girders. The girder is assumed to possess a doubly symmetric, open cross-section with principal axes oriented in the directions of the normal and binormal vectors to the helical curve described by the cross-section center of gravity. Differential equations of motion are derived based on A.E.H. Love's curvature and strain relationships modified to include warping effects. A closed form solution to the free vibration problem of a simply supported helical beam is used to study the effect on natural frequencies of varying the slope angle. Approximate frequency equations for all four coupled natural frequencies are also presented for the case of simple supports. A helical beam finite element is developed using quintic hermitian shape functions to approximate each of the four displacements -- axial, radial, vertical, and twisting -- of a point on the beam's centerline. Impact factors due to a moving load are compared for horizontally and helically curved single and two span continuous girders. Conclusions are presented concerning the effect of increased helix angle on impact factors and the applicability of the present method to cross-sections having only a vertical axis of symmetry.

82-1696

Vibration Analysis of a Flexible System Mounted on a Viscoelastic Sandwich Beam

R.C. Das Vikal, K.N. Gupta, and B.C. Nakra

Mech. Engrg. Dept., Muzaffarpur Inst. of Tech., Muzaffarpur-842003, India, J. Mech. Des., Trans. ASME, 104 (2), pp 445-452 (Apr 1982) 15 figs, 14 refs

Key Words: Beams, Sandwich structures, Viscoelastic core-containing media, Vibration analysis

Vibration analysis of a simple flexible system mounted arbitrarily on a three-layer sandwich beam having a viscoelastic core and elastic faces is presented. The flexible system consists of a mass on rubber spring and is excited harmonically. The expressions for displacement response of mass and transmissibility provided by the whole system are obtained. The displacement response and transmissibility are studied for different geometrical and physical parameters of the sandwich beam.

82-1697

Vibration Modes of Centrifugally Stiffened Beams

A.D. Wright, C.E. Smith, R.W. Thresher, and J.L.C. Wang

Rockwell Intl., Wind Systems Group, Rocky Flats, Golden, CO 80401, J. Appl. Mech., Trans. ASME, 49 (1), pp 197-202 (Mar 1982) 3 figs, 9 tables, 10 refs

Key Words: Beams, Stiffened beams, Variable material properties, Variable cross section, Natural frequencies, Mode shapes

The method of Frobenius is used to solve for the exact frequencies and mode shapes for rotating beams in which both the flexural rigidity and the mass distribution vary linearly. Results are tabulated for a variety of situations including uniform and tapered beams, with root offset and tip mass, and for both hinged root and fixed root boundary conditions. The results obtained for the case of the uniform cantilever beam are compared with other solutions, and the results of a conventional finite-element code.

82-1698

Soil Effects on Seismic Response of Chimneys

G.R. Aranda

Universidad Nacional Autonoma de Mexico, Inst. de Ingenieria, Mexico City, Mexico, Rept. No. E-45, 40 pp (Jan 1981)

PB82-138587

Key Words: Chimneys, Seismic response, Interaction: soil-structure

The seismic response of chimneys including soil conditions is analyzed. The foundation parameters are taken into account as functions of the shear wave velocity. Seismic forces are obtained from response spectra of real tremors and the structural response is calculated with an approximate method based on classical modal analysis. Results are presented as dimensionless interaction diagrams for displacement, shear force and overturning moment. Two types of structural damping are evaluated; that due to energy dissipation into the soil and that due to the flexibility of the footing. A comparison with results obtained for chimneys assuming rigid base conditions is also presented.

CYLINDERS

82-1699

Calculation of the Vibration of an Elastically Mounted Cylinder Using Experimental Data from Forced Oscillation

T. Staubli

Institute for Liquid Tech., Swiss Fed. Inst. of Tech., Zurich, Switzerland, "Fluid-Structure Interactions in Turbomachinery," Winter Annual Meeting of the ASME, Washington, DC, Nov 15-20, 1981, W.E. Thompson, ed., pp 19-24, 7 figs, 14 refs

Key Words: Cylinders, Vortex shedding, Hysteretic damping, Interaction: structure-fluid, Turbomachinery

Several methods for investigating the fluid-structure interaction of bodies vibrating due to vortex shedding are compared briefly. The advantage of employing a forced-displacement excitation method is asserted. This method has been adopted to measure the response of the fluid forces acting on an oscillating circular cylinder in crossflow. With the results of these measurements, and a calculation based on the assumption of sinusoidal motion, the vibrations of a freely oscillating cylinder are predicted in the lock-in range. It is shown that hysteresis effects, which are observed in experiments with elastically mounted cylinders of certain damping and mass ratios, are caused by the nonlinear relation between the fluid force and the amplitude of oscillation.

82-1700

Experimental Study of Noise Reduction for an Unstiffened Cylindrical Model of an Airplane Fuselage

C.M. Willis and E.F. Daniels
NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TP-1964-L-14878, 36 pp (Dec 1981)
N82-14879

Key Words: Aircraft, Cylinders, Noise reduction, Resonant frequencies, Damping

Noise reduction measurements were made for a simplified model of an airplane fuselage consisting of an unstiffened aluminum cylinder. Noise reduction was first measured with a reverberant field pink-noise load on the cylinder exterior. Noise reduction was then measured by using a propeller to provide a more realistic noise load on the cylinder. Structural resonance frequencies and acoustic reverberation times for the cylinder interior volume were also measured. Comparison of data from the relatively simple test using reverberant-field noise with data from the more complex propeller-noise tests indicates some similarity in both the overall noise reduction and the spectral distribution.

FRAMES AND ARCHES

82-1701

Linear Models to Predict the Nonlinear Seismic Behavior of a One-Story Steel Frame

H. Valdimarsson, A.H. Shah, and H.D. McNiven
Earthquake Engrg. Res. Ctr., Univ. of California, Berkeley, CA, Rept. No. UCB/EERC-81/13, NSF/CEE-81043, 180 pp (Sept 1981)
PB82-138793

Key Words: Buildings, Frames, Steel, Seismic response, Earthquake damage, Damage prediction

Six methods of linearization are used to construct various equivalent linear models to predict the nonlinear seismic behavior of a one-story steel frame. Four of the methods of linearization depend on the restoring force-displacement relation of the frame. Two bilinear models are constructed; one to represent the elastic-plastic nature of the structural steel, the other to represent the work hardening nature. Both bilinear models reproduce the response time histories quite accurately in the domain appropriate to each.

MEMBRANES, FILMS, AND WEBS

82-1702

The Vibration of Rotating Elastic Membrane Cylinders

D.M. Haughton
Dept. of Math., Univ. of Glasgow, Scotland, Intl. J. Engrg. Sci., 20 (7), pp 835-844 (1982) 3 figs, 13 refs

Key Words: Membranes (structural members), Cylindrical shells, Rotating structures, Vibration analysis

Using membrane theory the finite deformation of a right circular cylinder of compressible hyperelastic material rotating about its axis is investigated. A necessary and sufficient condition for axial shortening to accompany rotation is given. Small amplitude vibrations propagating on such a finitely deformed cylindrical membrane are considered. The same equations are shown to govern both the compressible and incompressible cases. For axi-symmetric vibrations analytical results are obtained and are used to show that neither pure torsional nor pure longitudinal vibrations can propagate in a rotating cylinder. Numerical results are given for a variety of different forms of vibration for a particular realistic material model.

82-1703

Formulation of a Dynamic Analysis Method for a Generic Family of Hoop-Mast Antenna Systems

A. Gabriele and R. Loewy
Rensselaer Polytechnic Inst., Troy, NY, Rept. No. NASA-CR-164981, 18 pp (Nov 2, 1981)
N82-12300

Key Words: Antennas, Membranes (structural members), Dynamic structural analysis, Transfer matrix method, Numerical analysis, Computer-aided techniques

Analytical studies of mast-cable-hoop-membrane type antennas were conducted using a transfer matrix numerical analysis approach. This method, by virtue of its specialization and the inherently easy compartmentalization of the formulation and numerical procedures, can be significantly more efficient in computer time required and in the time needed to review and interpret the results.

PLATES

82-1704

Numerical Methods for Nonlinear Dynamics of Plates and Shells

C.-S. Tsay
Ph.D. Thesis, Northwestern Univ., 106 pp (1981)
UM DA8204967

Key Words: Plates, Shells, Nonlinear theories, Impact force, Finite element technique

A finite element formulation and algorithm for the nonlinear analysis of the large deflection, materially nonlinear response of impulsively loaded shells is presented. A unique feature of this algorithm is the use of a bilinear four node quadrilateral element with single point quadrature and a simple hourglass control which is orthogonal to straining and rigid body modes on an element level. The geometric nonlinearities are treated by using a corotational description wherein a coordinate system that rotates with the material is embedded at the integration point; thus the algorithm is directly applicable to anisotropic materials without any corrections for frame invariance of material property tensors. This algorithm can treat about 200 element-time-steps per CPU second on a CYBER 170/730 computer in the explicit time integration code. Numerous results are presented for both elastic and elastic-plastic problems with large strains that show that the method in most cases is comparable in accuracy with an earlier version of this algorithm employing a cubic triangular plate-shell element, but considerably faster.

82-1705

Influence of the Aspect Ratio on the Dynamic Stability and Nonlinear Response of Rectangular Plates

G.L. Ostiguy and R.M. Evan-Iwanowski
Ecole Polytechnique, P.O. Box 6079, Station "A," Montreal, Canada H3C 3A7, J. Mech. Des., Trans. ASME, 104 (2), pp 417-425 (Apr 1982) 11 figs, 2 tables, 15 refs

Key Words: Plates, Rectangular plates, Parametric excitation, Nonlinear response

The dynamic stability and nonlinear response of simply-supported rectangular plates subjected to parametric excitation are investigated. The large-deflection plate theory used in the analysis is derived in terms of the stress function F and lateral displacement w and is applied to rectangular plates with stress-free supported edges and uniformly stressed loaded edges. General rectangular plates are considered, the aspect ratio of the plate being regarded as an additional parameter of the system. Calculations are carried out for rectangular plates of various aspect ratios, and the relative importance of the principal regions of parametric instability associated with the lower mode shapes is clarified. The stationary response of the system within a principal region of instability is also evaluated. The results obtained indicate that the aspect ratio plays a crucial role in determining the stability of rectangular plates; elongated plates are more susceptible to various parametric resonances than square plates.

82-1706

Large Amplitude Elliptical Plate Vibration with Transverse Shear and Rotatory Inertia Effects

M. Sathyamoorthy
Dept. of Mech. and Indus. Engrg., Clarkson College of Tech., Potsdam, NY 13676, J. Mech. Des., Trans. ASME, 104 (2), pp 426-431 (Apr 1982) 5 figs, 1 table 9 refs

Key Words: Plates, Flexural vibration, Large amplitudes, Transverse shear deformation effects, Rotatory inertia effects

An improved nonlinear vibration theory is used in the present analysis to study the effects of transverse shear deformation and rotatory inertia on the large amplitude vibration behavior of isotropic elliptical plates. When these effects are negligible the differential equations given here readily reduce to the well-known dynamic von Karman equations. Based on a single-mode analysis, solutions to the governing equations are presented for immovably clamped elliptical plates by use of Galerkin's method and the numerical Runge-Kutta procedure. An excellent agreement is found between the present results and those available for nonlinear bending and large amplitude vibration of elliptical plates. The present results for moderately thick elliptical plates indicate significant influences of the transverse shear deformation, axes ratio, and semi-major axis-to-thickness ratio on the large amplitude vibration of elliptical plates.

82-1707

Dynamic Response of a Rectangular Plate with Initial Imperfections under Large In-Plane Forces

H. Pasic, D. Juricic, and G. Herrmann
Div. of Appl. Mech., Stanford Univ., Stanford, CA, J. Mech. Des., Trans. ASME, 104 (2), pp 432-438 (Apr 1982) 6 figs, 7 refs

Key Words: Plates, Rectangular plates, Geometric imperfection effects

This paper presents an analysis of the response of an imperfect, finite, simply-supported, rectangular plate under an in-plane above-critical force applied during a short time at one of the edges in the direction perpendicular to the edge.

The influence of the initial irregularities on the overall response during and after load application is analyzed. The results indicate that the frequency spectrum of free vibrations, after removal of the load, is controlled by the initial irregularity distribution, the plate geometry, and the load level.

The energy functional is minimized with respect to discretized displacement components and the natural frequencies and corresponding mode shapes are obtained from the solution of a linear eigenvalue problem. The effect of inplane deformations of the plate and the stiffener and also the effect of inplane inertia on free vibration characteristics of uniaxial and cross-stiffened plates have been examined.

82-1708

Analysis of Plate Vibrations Using Superelements

O.A. Pekau and H.P. Huttelmaier

Dept. of Civil Engrg., Concordia Univ., Montreal, Canada H3G1M8, J. Mech. Des., Trans. ASME, 104 (2), pp 439-444 (Apr 1982) 6 figs, 6 tables, 15 refs

Key Words: Plates, Substructuring methods, Finite element technique

A rectangular substructure or superelement is described for use in the vibrational analysis of plates and flat plate assemblies. Basic features include elimination of internal nodes and flexibility in the location of nodes along the boundaries. Illustrative examples demonstrate the efficient and versatile application of the element. The main focus, however, is on solution accuracy for different representations of mass. In particular, it is found that the homogeneous inertia properties of a plate must be expressed by a consistent substructure mass matrix in order to model dynamic properties accurately.

82-1709

Free Vibration Analysis of Stiffened Plates by Including the Effect of Inplane Inertia

G. Aksu

Mech. Engrg. Dept., Middle East Technical Univ., Gaziantep Campus, Gaziantep, Turkey, J. Appl. Mech., Trans. ASME, 49 (1), pp 206-212 (Mar 1982) 10 figs, 2 tables, 12 refs

Key Words: Plates, Stiffened plates, Finite difference technique, Natural frequencies, Mode shapes

A method based on the variational principles in conjunction with the finite difference technique is applied to determine the dynamic characteristic of eccentrically stiffened plates. The inplane deformations in both directions of the plate have been considered and the inplane inertia has been included into the analysis. The strain and kinetic energy for the plate and the stiffener are expressed in terms of discrete displacement components using the finite difference method.

82-1710

Geometrically Nonlinear Transient Analysis of Laminated Composite Plates

J.N. Reddy

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, Rept. No. VPI-E-82.8, 34 pp (Mar 1982)

Key Words: Plates, Composite structures, Layered materials, Fiber composites, Geometric effects, Transverse shear deformation effects, Transient response

Forced motions of laminated composite plates are investigated using a finite element that accounts for the transverse shear strains, rotary inertia, and large rotations (in the von Karman sense). The present results when specialized for isotropic plates are found to be in good agreement with those available in the literature. Numerical results of the nonlinear analysis are presented showing the effects of plate thickness, lamination scheme, boundary conditions, and loading on the deflections and stresses. The new results for composite plates should serve as bench marks for future investigations.

82-1711

Transient Response of Laminated, Bimodular-Material, Composite Rectangular Plates

J.N. Reddy

Dept. of Engrg. Sci. and Mech., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, Rept. No. VPI-E-81-28, 22 pp (Oct 1981)

Key Words: Plates, Rectangular plates, Composite structures, Transient response, Finite element technique

Finite-element and closed-form solutions to the equations of motion governing layered composite plates of bimodular materials are presented for rectangular plates with all edges simply supported without in-plane restraint and tangential rotation and subjected to suddenly applied, sinusoidally distributed, transverse loadings. Finite element results are also presented for the same problem but with uniformly distributed step loading. The finite element results are found to be in good agreement with the closed-form solutions.

82-1712

Solving Free Vibration's Frequencies and Modes of Sandwich Trapezoidal Plates

K[illegible]esnikov and V. Shalashilin
Moskovskii ordena Lenina aviatsionni institut im. Sergo Ordzhnikidze, USSR, Vibrotechnika, 2 (36), pp 39-47 (1981) 4 figs, 8 refs
(In Russian)

Key Words: Plates, Sandwich structures, Natural frequencies, Mode shapes

An algorithm for solving natural frequencies and mode shapes of simply supported trapezoidal sandwich plates is presented. It is based on membrane analogy, method of lines and finite functional Fourier series. The accuracy of the method is evaluated and some numerical results are demonstrated.

82-1713

Natural Frequencies of Transversal Oscillations, Deflections and Tensions of the Constructive-Orthotropic Plate

V. Paliūnas and Z. Vyšniauskiene
Kauno polytechnikas institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (31), pp 31-40 (1981) 5 refs
(In Russian)

Key Words: Plates, Orthotropism, Natural frequencies, Flexural vibration

Static and dynamic response of orthotropic plates with freely supported opposite edges is discussed. Static deflection of plates under uniformly distributed loads was determined using E. Ginke's differential equations. Exact and approximate calculations of natural frequencies of transverse oscillations were carried out by means of the Ritz method.

SHELLS

(Also see Nos. 1702, 1704)

82-1714

Analysis of Cyclic Plasticity, Fatigue and Fracture of Thick-Walled Cylinders

N. Tomita
Ph.D. Thesis, Univ. of Illinois at Urbana-Champaign, 232 pp (1981)
UM DA8203617

Key Words: Cylinders, Cylindrical shells, Steel, Fatigue life, Fracture properties

A mathematical model which predicts transient cyclic stress-strain behavior of low alloy, high strength steel has been developed. The model has been successfully applied to both uniaxial and proportional multiaxial (thick-walled cylinder) cyclic loadings. It has been commonly accepted that once a thick-walled cylinder has been autofrettaged, no further plastic deformation will occur when the same pressure is applied again. This is found not to be true. Instead, the plastic-elastic boundary may propagate during each pressure cycle and lead to complete plastic deformation to the outer diameter after a certain number of cycles. This phenomenon has been observed experimentally by many researchers in the past when tangential strains at the outer diameter were found to increase during repeated autofrettage but no explanation has been given for this "strain walking." The present research suggests a new autofrettaging process that results in much higher residual compressive stresses but with less than one tenth of the diametral dilation at the bore than obtained with traditional autofrettaging methods.

82-1715

Structural and Acoustic Response of Submerged Axisymmetric Shells

A.J. Bronowicki and R.B. Nelson
TRW Dynamics Dept., Redondo Beach, CA, "Computational Methods for Infinite Domain Media-Structure Interaction," Winter Annual Meeting of the ASME, Washington, DC, Nov 15-20, 1981, AMD-Vol. 46, A.J. Kalinowski, ed., pp 37-66, 11 figs, 5 tables, 33 refs

Key Words: Shells, Bodies of revolution, Submerged structures, Frequency domain method, Interaction: structure-medium, Interaction: structure-fluid, Acoustic response, Structural response

The frequency domain response of arbitrary closed shells of revolution immersed in an infinite acoustic medium is considered. A reduction in dimensionality of the problem is achieved through a decomposition of motion into circumferential harmonics. The acoustic relation is thus represented as an integral equation defined along the shell meridian. This relation, derived on the basis of a Green's function technique featuring toroidal wave functions, is applicable to surfaces having arbitrary meridional shape, including corners. In order to assure uniqueness of solution, interior equations are appended to the set of surface integral equations. The concept of an acoustic element is introduced with meridional pressure variation determined by the response at a number of surface pressure nodes.

82-1716
Modeling Techniques for Analysis of Stiffened Shell Structures, Using Computer Program ADINA
T.A. Giacofci
David W. Taylor Naval Ship Res. and Dev. Ctr., Bethesda, MD, Rept. No. DTNSRDC-81/070, 29 pp (Nov 1981)
AD-A108 728

Key Words: Stiffeners, Transient response, Stiffened shells, Mathematical models

The beam element available in computer program ADINA is inadequate for transient analysis of eccentrically stiffened shell structures, particularly when the lateral stability of the stiffener is of concern. As an alternative to modeling shell stiffeners with numerous continuum or transition elements, a stiffener modeling technique based on the multipoint constraint option in ADINA is presented. This technique leads to significant reductions in the number of elements and solution degrees of freedom needed for accurate stiffener modeling, yet allows inclusion in the analysis of effects of out-of-plane web distortion, longitudinal warping, and torsion. Stiffeners having various cross sectional geometries and boundary conditions have been modeled, and predicted response correlates well with experimental data. The approach is of practical significance for large stiffened shell problems, especially nonlinear analysis.

82-1717
Analytical Method for Determining Seismic Response of Cooling Towers on Footing Foundations
P.L. Gould, O. El-Shafee, and B.-J. Lee
Dept. of Civil Engrg., Washington Univ., St. Louis, MO, Rept. No. RR-60, NSF/CEE-81058, 169 pp (Oct 1981)
PB82-148008

Key Words: Towers, Cooling towers, Shells, Shells of revolution, Foundations, Interaction: soil-structure

The development of a finite element model for the dynamic analysis of an axisymmetric thin rotational shell founded on a shallow ring footing is described. The model was developed using high-precision rotational elements for the shell, isoparametric solid elements for the soil, and an energy transmitting boundary at the ring footing.

82-1718
Asymmetric Free Vibrations of Layered Conical Shells
K. Chandrasekaran and V. Ramamurti
College of Engrg., Perarignar Anna Univ. of Tech., Madras-600025, India, J. Mech. Des., Trans. ASME, 104 (2), pp 453-462 (Apr 1982) 12 figs, 2 tables, 14 refs

Key Words: Shells, Conical shells, Layered materials, Energy methods, Rayleigh-Ritz method, Vibration analysis

Asymmetric free vibrations of layered truncated conical shells are studied. Individual layers made of special orthotropic materials and both symmetric and asymmetric stacking with respect to the middle surface are considered. An energy-method based on the Rayleigh-Ritz procedure is employed. The influence of layer arrangements and that of the coupling between bending and stretching on the natural frequencies and mode shapes are analyzed. Experimental results from tests on two shell models are provided for comparison with theoretical predictions. Numerical results based on extensive parametric studies are presented.

RINGS

(Also see Nos. 1731, 1732, 1733)

82-1719
Kinematics of Wave Processes in Rings
G. Markauskaite and L. Patašiene
Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (31), pp 133-136 (1981) 4 figs, 1 ref
(In Russian)

Key Words: Rings

The kinematics of wave processes in rings were studied. Mode shapes of rings, used as exciters in the oscillation engines, were also considered.

PIPES AND TUBES

(Also see Nos. 1745, 1837)

82-1720
Development of Acceptance Criteria for Piping Vibration Testing
G. Listvinsky
Ebasco Services, Inc., New York, NY, "Vibration in Power Plant Piping and Equipment," Joint Confer-

ence of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. R.C. Iotti, ed., pp 39-46, 10 figs, 1 table, 3 refs

Key Words: Piping systems, Nuclear power plants, Vibration tests

A methodology is presented for steady state vibration testing of nuclear power plants piping systems. To simplify and minimize the testing efforts, three levels of tests of different complexity are identified. Successive testing levels should be used only for those portions of piping for which the results on the preceding levels are negative. Respective acceptance criteria and testing requirements are given. The last level of testing is, in essence, local forced vibration analysis. The approach developed is applicable to steady state vibration testing of any frame-type structure.

82-1721
Mathematical Basis of a Dynamic Structural Analysis Method for Piping
K. Gordis
Appl. Mech. Section, Ebasco Services, Inc., Geneva, Switzerland, "Vibration in Power Plant Piping and Equipment," Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. R.C. Iotti and M.D. Bernstein, eds., pp 13-23

Key Words: Piping systems, Nuclear power plants

The paper deals, in a coherent mathematical manner, with a number of theoretical and practical problems involved in the solution of dynamic structural problems encountered for piping systems in nuclear power plants.

82-1722
A Sensitivity Analysis of Vibration in Power Plant Piping Systems
D.S. Young
Harry J. Sweet and Assoc., Inc., Houston, TX, "Vibration in Power Plant Piping and Equipment," Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. R.C. Iotti and M.D. Bernstein, eds., pp 25-30, 1 fig, 3 tables, 14 refs

Key Words: Piping systems, Nuclear power plants, Sensitivity analysis

In order to facilitate the dynamic design process of power plant piping systems it is desired to have a method that does not require a trial-and-error procedure based on total structural system re-analysis or re-design. In this paper a new sensitivity analysis method is presented that allows the designer to make structural modifications to optimize the design with respect to vibration or seismic resistance. To implement this method the structural response is first expressed in terms of the system eigendata. An efficient procedure for determining sensitivity of the structural response to changes in individual structural system parameters is then developed utilizing the eigenvalue and eigenvector derivatives with respect to the system design parameters. An example of a lumped mass structural model with four-degree-of-freedom is used to illustrate the technique.

82-1723
Experimental and Analytical Results of Blast Induced Seismic Studies at HDR
G.L. Thinnes and R.G. Rahl
EG and G Idaho, Inc., Idaho Falls, ID, Rept. No. EGG-2158, 194 pp (Nov 1981)
NUREG/CR-2463

Key Words: Piping systems, Nuclear reactor components, Ground motion, Underground explosions

The response of nuclear power plant piping systems subjected to ground excitation has been studied. The HDR is a decommissioned reactor being used for structural and hydraulic research. Analytical comparisons to the tested structural response of the HDR recirculation loop piping to explosive and shaker induced excitations were made. Acceleration results of linear and nonlinear transient time history analyses were compared to accelerometer data recorded on the piping loop in response to an explosive charge detonated in the ground outside the reactor containment building. Modal analyses were also performed and compared to results of experimental tests which excited the piping system with mechanical shakers.

82-1724
A Program for Preoperational Vibration Testing of Nuclear Power Plant Piping
K.N. Chow, G. Listvinsky, J. Flaherty, and L. Rogers
Ebasco Services, Inc., New York, NY, "Vibration in Power Plant Piping and Equipment," Joint Conf. of

the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. R.C. Iotti, ed., pp 47-52, 3 figs, 3 tables, 5 refs

Key Words: Piping systems, Nuclear power plants, Vibration tests, Vibration measurement

An approach to implementing a test program for preoperational and start-up vibration monitoring and testing of nuclear power plant piping, in particular for piping outside the Reactor Coolant Pressure Boundary, is presented. This program has been developed to assure reliability and plant safety with respect to vibration while minimizing cost and delay during plant start-up. This is accomplished by performing as much engineering and analysis prior to actual testing as practical. Consideration for selecting fluid system operating modes and justifications for the use of simplified vibration measurement techniques are presented. Preliminary testing experience using simplified measurement techniques is briefly discussed.

82-1725

Dynamic Analysis Techniques - A Sensitivity Study for Piping Systems at a Nuclear Power Plant

H. Suryoutomo and R. Bacher

Earthquake Engrg. Systems, Inc., San Francisco, CA, "Current Topics in Piping and Pipe Support Design," Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. ASME-PVP-Vol. 53. E. Van Stijgeren, ed., pp 159-171, 3 figs, 3 tables, 4 refs

Key Words: Piping systems, Nuclear power plants, Seismic analysis

The original seismic analysis of the piping systems for a nuclear power plant considered two different seismic load cases. Each case represented the response due to a combination of the vertical component and one of the two orthogonal horizontal components (N-S or E-W) of an earthquake. The highest response of the two load cases was used to evaluate the piping systems. The study presented was performed to evaluate the differences in the piping stresses and pipe support loads obtained from these two analytical approaches. This study also includes the effect of the differential seismic anchor movements, calculated support stiffnesses and the effects of closely spaced modes in the modal summation procedure, and compares the relative results of the two analytical approaches.

82-1726

Evaluation of Pipe Support Stiffness and Its Effect on Piping Response

T.Y. Chow, C.H. Chen, and O. Bilgin

Stone and Webster Engrg. Corp., Cherry Hill Operations Ctr., Cherry Hill, NJ, "Current Topics in Piping and Pipe Support Design," Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. ASME-PVP-Vol. 53. E. Van Stijgeren, ed., pp 105-115, 10 figs, 1 table, 3 refs

Key Words: Piping systems, Supports, Nuclear power plants

In performing stress analysis of nuclear piping systems, support stiffness values are first estimated and used as inputs to predict the responses of the piping systems. However, the actual support stiffness values will not be known until the supports are designed. The difference between the actual support stiffness and that used in pipe stress analysis may introduce changes in the piping response. Therefore, it is desirable to develop simplified criteria to assess the adequacy of the piping system with differences between estimated and actual support stiffnesses.

82-1727

Optimum Rigid Support Spacing for Eccentric Operator Valves

J. Gorga, E. Montgomery, and M. Ramchandani

Burns and Roe, Inc., Oradell, NJ, "Current Topics in Piping and Pipe Support Design," Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. ASME-PVP-Vol. 53. E. Van Stijgeren, ed., pp 117-143, 9 figs, 2 tables, 7 refs

Key Words: Piping systems, Supports, Valves

The results and technical implications of the optimum support configuration used in eccentric operator type valves are examined. The approach presented develops an equivalent rigid restraint spacing criteria using a rotatory inertia mathematical model. This model is based on the formulation of eccentric mass transfer matrices. The frequency equations for concentric and eccentric valve mass models are compared. Using a frequency design criteria the maximum allowable span lengths are derived. In light of the stringent requirements for valve qualification in the nuclear industry, guidelines in the form of simplified computational procedures and tables are provided for in plane and out of plane vibratory modes using pipe flexibility, valve/operator inertia and eccentricity.

circumferential through cracks in pipes subjected to axial tension.

82-1728

Effects of Support Stiffness on Pipe Vibration

M.Z. Lee
Dept. of Specialty Engrg., Gilbert/Commonwealth, Reading, PA, "Vibration in Power Plant Piping and Equipment," Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. R.C. Iotti and M.D. Bernstein, eds., pp 31-38, 5 figs, 2 tables, 3 refs

Key Words: Piping systems, Supports, Stiffener effects, Beams, Springs, Seismic response

The effects of support flexibility on piping vibration are studied by considering the lateral vibration of beams supported by springs. The seismic responses of flexibly supported pipes, including acceleration, shear, moment, and deflection, are compared to those of rigidly supported pipes. Parameters reflecting the effects of natural frequency, mode shapes, and participation factors on those responses are given. Several methods of characterizing support stiffness used in the industry are studied. A mathematical derivation is given to explain the key concept of the effect of support stiffness on frequency-shift. The frequency invariant method of controlling seismic responses is given and applied to seismic support spacing criteria to justify many support types which would be unacceptable by a support deflection or a support frequency criterion.

82-1729

Static Stress-Intensity Factors and Dynamic Crack Propagation in Pipes. Annual Report, September 1981

A.F. Emery, A.S. Kobayashi, and W.J. Love
Dept. of Mech. Engrg., Washington Univ., Seattle, WA, Rept. No. EPRI-NP-2024, 206 pp (Sept 1981)
(Microfiche only)
DE82900365

Key Words: Pipes (tubes), Crack propagation, Fatigue (materials), Computer programs

Predictive models for critical flaw sizes, initiation and propagation of dynamic cracks in pipes, and the behavior of dynamic crack propagation in compact specimens are described. Parametric results are reported that may be used to predict critical flaw sizes for the initiation of a running crack as well as the crack propagation rate under fatigue in precracked pressurized and thermally shocked cylinders and nozzle-cylinder intersections. Fundamental properties governing rapid crack propagation and crack arrest are described, as are studies on the initiation and propagation of

82-1730

On Turbulent Secondary Flows in Pipes of Noncircular Cross-Section

C.G. Speziale
Dept. of Mech. Engrg., Stevens Inst. of Tech., Hoboken, NJ 07030, Intl. J. Engrg. Sci., 20 (7), pp 863-872 (1982) 2 figs, 13 refs

Key Words: Pipes (tubes), Turbulence

The origin of turbulent secondary flow in pipes of noncircular cross section is examined from a theoretical standpoint. It is proven mathematically that secondary flows result from a nonzero difference in the normal Reynolds stresses on planes perpendicular to the axial flow direction. It is shown that the $K - \epsilon$ model of turbulence has no natural mechanism for the development of secondary flow while the currently popular second-order closure models do. The implications that this has on turbulence modeling are discussed briefly.

82-1731

Exploration of Dynamic Stability of Manometrical Tube

M. Tulegenov
Arkalikskii pedagogitcheskii institut im. T. Altinsarina, USSR, Vibrotechnika, 1 (31), pp 55-61 (1981) 2 figs, 5 refs
(In Russian)

Key Words: Tubes, Circular tubes, Internal pressure, Dynamic stability

An algorithm for the calculation of parametric vibrations of a manometrical tube is developed. Equations for solving low amplitude vibrations caused by internal pressure pulsations are presented. In the first approximation, by means of Galerkin's formula, the system is reduced to the ordinary differential equation. The stability diagram of the manometrical tube is obtained, which enables to define material characteristics and geometry of the tube and thus ensure its dynamic stability under the given amplitude and pressure pulsations.

28-1732

Definition of Frequencies and Forms of Free Oscillations of the Manometrical Tube

M. Tulegenov

Arkalikskii pedagogicheskii institut, im. T. Altinsarina, USSR, Vibrotechnika, 2 (32), pp 33-38 (1981) 2 figs, 7 refs
(In Russian)

Key Words: Tubes, Circular tubes, Natural frequencies, Mode shapes, Internal pressure

An algorithm for numerical analysis of frequencies and mode shapes of free oscillation of the manometrical tube is presented. The equation for calculating low frequency oscillation of the circular axis tube under internal pressure is given. Using the method of initial parameters the first three frequencies and corresponding latent vectors for several pressures are calculated. Since all parameters are dimensionless, the results can be used in the dynamic analysis of various manometrical tubes.

82-1733

Oscillations of the Manometrical Tube under the Influence of the Outside Inertial Field

O. Naraikin and M. Tulegenov

Moskovskoe visshee technicheskoe uchilishche im. M.E. Baumana, USSR, Vibrotechnika, 2 (32), pp 67-75 (1981) 3 figs, 9 refs
(In Russian)

Key Words: Tubes, Circular tubes, Random excitation, Inertial forces

An algorithm describing oscillations of a manometrical tube in a random inertial field is presented. A system of equations is given to predict low oscillations of a circular axis tube under internal pressure in a random external inertial field. The surface of the tube coincides with the surface of the inertial field. The correlation function and the full displacement dispersion of free end of the tube during arbitrary random exposure were derived. Time dependency of the mean square deviation on the full displacement of the free end of the tube under a white noise disturbance is obtained.

82-1734

Flow-Induced Vibration of a Curved Tube Array Subject to Liquid Cross Flow

J.A. Jendrzejczyk and S.S. Chen

Components Tech. Div., Argonne Natl. Lab., Argonne, IL, "Vibration in Power Plant Piping and Equipment," Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. R.C. Iotti and M.D. Bernstein, eds., pp 5-11, 9 figs, 1 table, 4 refs

Key Words: Curved pipes, Tubes, Tube arrays, Fluid-induced excitation, Natural frequencies

Results of tests of a curved tube array in air, in stationary water, and in flowing fluid are presented. A curved tube array can be subjected to fluidelastic instability which is similar to that in a straight tube array. However, in a curved tube array, tube natural frequencies are different in two directions and there are frequency variations among different tube rows; the critical flow velocity and instability mode are not the same as those of the corresponding straight tube array. Based on the experimental data, and a mathematical consideration, it can be concluded that some of the instability modes will not occur in a curved tube array; therefore, the critical flow velocity established for straight tube arrays can be considered as a conservative estimate for a corresponding curved tube array.

82-1735

Transverse Impact on Fluid-Filled Cylindrical Tubes

F. Katsamanis and W. Goldsmith

Naval College, Athens, Greece, J. Appl. Mech., Trans. ASME, 49 (1), pp 149-156 (Mar 1982) 10 figs, 3 tables, 10 refs

Key Words: Tubes, Cylinders, Fluid-filled containers, Impact response

An analytical and experimental study was conducted regarding the effects produced by transverse impact of spherical steel projectiles on circular elastic tubes either empty or containing stationary or flowing fluids. Similar tests were also executed on acrylic (PMMA) tubes that exhibit viscoelastic behavior.

82-1736

Fundamental Frequencies of U-Tubes in Tube Bundles

P.M. Moretti

Oklahoma State Univ., Stillwater, OK, "Vibration in Power Plant Piping and Equipment," Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. R.C. Iotti and M.D. Bernstein, eds., pp 1-4, 3 figs, 12 refs

Key Words: Tube arrays, Tubes, Heat exchangers, Fundamental frequency

The natural frequencies of U-tubes on multiple supports have been studied as a complement to the author's previous work on the vibration of straight heat-exchanger tubes. A rapid estimation procedure for fundamental frequencies of tubes with symmetrical support spacings has been developed.

82-1737

Dynamic Behavior of a Buried Pipe in a Seismic Environment

S.K. Datta, A.H. Shah, and N. El-Akily

Dept. of Mech. Engrg., Univ. of Colorado, Boulder, CO, J. Appl. Mech., Trans. ASME, 49 (1), pp 141-148 (Mar 1982) 13 figs, 2 tables, 13 refs

Key Words: Life line systems, Pipes (tubes), Underground structures, Seismic response, Shells, Cylindrical shells, Elastic media

Axisymmetric dynamic response of a buried pipe due to an incident compressional wave is the subject of this investigation. The pipe has been modeled as a thin cylindrical shell of linear homogeneous isotropic elastic material embedded in a linear isotropic homogeneous elastic medium of infinite extent. The response characteristics of the pipe due to changes in the material properties of the surrounding medium have been carefully studied. It is found that even at long wavelengths and low frequencies, the dynamic response is significantly altered by the changes in the Poisson's ratio and the rigidity modulus of the surrounding medium. Further, it is found that there are real resonant frequencies of the pipe that are also significantly dependent on these quantities, as well as on the wavelength.

DUCTS

82-1738

A Finite Element Method for Computing Sound Propagation in Ducts Containing Flow

D.W. Quinn

Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH, Rept. No. AFWAL-TR-81-3087, 31 pp (Sept 1981)

AD-A108 836

Key Words: Ducts, Fluid-filled containers, Sound propagation, Finite element technique

Solutions of the equations which describe sound propagation in nonuniform ducts containing flow are computed with a finite element approach. A least squares approach is considered and compared to a Galerkin approach. The least squares problem is solved using an iterative method and compared with results obtained using direct Gaussian elimination. The accuracy of linear basis functions on triangles, bilinear basis functions on rectangles, and biquadratic basis functions on rectangles are compared. For the nonuniform ducts, the use of quadrilaterals as elements and an isoparametric map are considered.

82-1739

The Excitation of Compressor/Duct Systems

R.E. Peacock and D.K. Das

Naval Postgraduate School, Monterey, CA, "Fluid-Structure Interactions in Turbomachinery," Winter Annual Meeting of the ASME, Washington, DC, Nov 15-29, 1981, W.E. Thompson, ed., pp 71-78, 14 figs, 1 table, 5 refs

Key Words: Ducts, Compressors, Cyclic loading, Fluid-induced excitation, Interaction: structure-fluid, Turbomachinery

A series of experiments is reported in which the flow through a compressor/duct combination was perturbed in a cyclic way. The unsteady flows generated were mapped through the system in the regime of stable compressor operations and the variation of their magnitude evaluated. It was found that in approaching the stability limit the stagnation pressure pulses tended to be magnified and that the position of the stability limit line depended both upon the mean operating point of the compressor and the pulsation characteristics.

82-1740

Application of Steady State Finite Element and Transient Finite Difference Theory to Sound Propagation in a Variable Area Duct: A Comparison with Experiment

K.J. Baumeister, W. Eversman, R.J. Astley, and J.W. White

NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TM-82678, E-960, 14 pp (1981) (Pres. at the 7th Aeroacoustics Conf., Palo Alto, CA, Oct 5-7, 1981)

N82-15847

Key Words: Ducts, Variable cross section, Sound waves, Wave propagation, Finite element technique, Finite difference technique

Sound propagation without flow in a rectangular duct with a converging-diverging area variation was studied experimentally and theoretically. The area variation was of sufficient magnitude to produce large reflections and induce modal scattering. The rms (root-mean-squared) pressure and phase angle on both the flat and curved surface were measured and tabulated. The steady state finite element theory and the transient finite difference theory are in good agreement with the data. It is concluded that numerical finite difference and finite element theories appear ideally suited for handling duct propagation problems which encounter large area variations.

82-1741

On the Influence of the Nozzle External Configuration on the Radiated Screech and the Decay of Supersonic Jets

G.M. Carlomagno, C. Ianniello, and P. Vigo

Inst. of Aerodynamics, Univ. of Naples, Naples, Italy 80125, Arch. Acoust., 6 (2), pp 123-134 (1981) 6 figs, 21 refs

Key Words: Nozzles, Jet noise, Noise generation

The behavior of screeching jets exhausting from an axisymmetric convergent-divergent nozzle was studied. Compressed nitrogen was used to obtain nozzle stagnation pressures from 0.15 to 1.4 MPa (absolute), i.e., conditions of overexpanded, correctly expanded and underexpanded streams at the nozzle exit section. The jet exhausted into a free field room and tests were performed for several nozzle external configurations. Measurements were made in terms of noise level emitted by the jet and impact pressure downstream.

82-1742

Radiation Impedance of an Unflanged Pipe with Mean Flow

V.B. Panicker and M.L. Munjal

Dept. of Mech. Engrg., N.S.S. Engrg. College, Palgat 678 008, India, Noise Control Engrg., 18 (2), pp 48-51 (Mar-Apr 1982) 4 figs, 17 refs

Key Words: Exhaust systems, Pipes (tubes), Exhaust noise, Acoustic impedance

Methods used in estimating tail pipe radiation characteristics are reviewed. The pressure reflection coefficient and the radiation impedance of a tail pipe with a moving medium are evaluated from standing wave measurements at discrete positions. Empirical relations for the pressure reflection coefficient (modulus and phase angle) and the radiation resistance and reactance in the presence of mean flow, are derived from experimental observations in circular pipes of different diameters.

82-1743

Determination of Two-Stroke Engine Exhaust Noise by the Method of Characteristics

A.D. Jones and G.L. Brown

NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TM-84061, 48 pp (June 1981)

N82-13827

Key Words: Engine noise, Ducts, Sound propagation, Method of characteristics

A computational technique was developed for the method of characteristics solution of a one-dimensional flow in a duct as applied to the wave action in an engine exhaust system. By using the method, it was possible to compute the unsteady flow in both straight pipe and tuned expansion chamber exhaust systems as matched to the flow from the cylinder of a small two-stroke engine. The radiated exhaust noise was then determined by assuming monopole radiation from the tailpipe outlet. Very good agreement with experiment on an operation engine was achieved in the calculation of both the third octave radiated noise and the associated pressure cycles at several locations in the different exhaust systems.

BUILDING COMPONENTS

(Also see Nos. 1701, 1765)

82-1744

Structural Walls in Earthquake-Resistant Buildings: Dynamic Analysis of Isolated Structural Walls. Development of Design Procedure - Design Force Levels

A.T. Derecho, M. Iqbal, S.K. Ghosh, M. Fintel, and W.G. Corley

Construction Tech. Labs., Portland Cement Assn., Skokie, IL, Rept. No. NSF/CEE-81061, 366 pp (July 1981)

PB82-147794

Key Words: Walls, Earthquake resistant structures, Ground motion, Design techniques, Computer programs

A procedure is used to establish estimates of strength, stiffness, and deformation demands of isolated structural walls subjected to ground motions of varying intensity. The investigation characterizes earthquake ground motions to select critical input motions, identifies the most significant structural and ground motion parameters, and formulates a simple design procedure for correlating earthquake demands with structural capacities. The computer program that was used to analyze the variables, DRAIN-2D, is described. The compilation of maximum or near-maximum values of the significant response quantities is shown to be a major step in determining design force levels for earthquake-resistant structural walls. The procedure, which is based on fundamental period and flexural yield level, is illustrated for the case of twenty-story walls subjected to input motions.

82-1745

Multiple Floor Response Spectral Analysis Concept and Modeling Considerations

M.J. Yan

RCS Component Engrg., The Babcock and Wilcox Co., Nuclear Power Generation Div., Lynchburg, VA, "Current Topics in Piping and Pipe Support Design," Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of ASME, Denver, CO, June 21-25, 1981. ASME-PVP-Vol. 53. E. Van Stijgeren, ed., pp 145-157, 5 figs, 2 tables, 6 refs

Key Words: Floors, Piping systems, Spectrum analysis, Supports

Most piping systems are supported at several locations where floor response spectra are defined. Current solution techniques applied to such systems use either a single envelope response spectral technique or a multiple response spectral technique. The first technique uses theory derived based on a single ground excitation to the building foundation. The single response spectrum input is obtained by enveloping the given response spectra. The second technique uses theory derived based on multiple ground excitations to pipe lines or other structures supported at more than one ground point, not floor attachment point. A modified method is proposed which is based on the floor response spectral input. The method considers the piping system and its supporting building to be coupled at specified multiple anchor points. The coupled structure is then considered as a light secondary system and decoupled from the structure as required. The ground response spectra are input to the secondary piping system at the multiple anchor points, which are considered to be fixed.

82-1746

On the Method of Solving Characteristic Values Problem

V. Kostrov

Moskovskii ordena Lenina aviatsionnii institut im Serno Ordzhonikidze, USSR, Vibrotechnika, 2 (36), pp 7-14 (1981) 7 figs, 2 refs

(In Russian)

Key Words: Structural members, Natural frequencies, Variational methods, Finite difference method

A numerical-analytical method for solving characteristic value problems is presented. It is based on the Vlasov-Kantorovitch variational method and the finite difference method. Numerical calculations of natural frequencies of conical and cylindrical members are presented.

ELECTRIC COMPONENTS

MOTORS

82-1747

Vibrational Mercury Commutator Equipment Dynamics. 1. Transition of Motion Conditions

D. Gvaldiene and V. Ragulskiene

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (36), pp 139-143 (1981) 5 figs, 5 refs

(In Russian)

Key Words: Motors, Transient response

The results of theoretical investigation on dynamics of transitory motion conditions of vibrational mercury commutator equipment are presented and the differential equalization of mercury drop motion is observed. The highest characteristics of mercury drop acceleration are presented. Some single pulse characteristics are given.

82-1748

Vibrational Mercury Commutator Equipment Dynamics. 2. Steady State Motion Conditions

D. Gvaldiene and V. Ragulskiene

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (36), pp 145-149 (1981) 9 figs, 4 refs
(In Russian)

Key Words: Motors, Transient response

The results of theoretical investigation on dynamics of steady-state motion conditions of vibrational mercury commutator are presented. Areas of existence and stability of conditions of motion are determined. Velocity rate characteristics survey is given; the influence of solid and viscous friction and resistance forces are clarified. The efficiency of vibrational mercury commutator is determined.

ELECTRONIC COMPONENTS

82-1749
Test Data on Leadless Chip Carriers with Ceramic Substrates in Severe Random Vibration Environments
J. Henderson
Litton Guidance and Control Systems, Woodland Hills, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 83-86, 6 figs

Key Words: Electronic equipment, Random excitation, Design techniques

The present trend of system design and development is toward compactness; i.e., to allow as many functions in the smallest volume as possible. To achieve this, electronics evolution begins through steps of a hybrid, an integrated circuit, small scale integration, medium scale integration, and large scale integration (LSI). Relatively new in the electronic packages are the hermetic chip carriers (HCC) that are having widespread acceptance. LSI technology, coupled with HCC packaging concept, offers density that is two to five times more dense than conventional dual-in-line or flatpack concepts.

82-1750
Random Vibration Testing and Analysis of a Large Ceramic Substrate Assembly
H. Gurien
Litton Guidance and Control Systems, Woodland Hills, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 93-98, 7 figs, 2 refs

Key Words: Electronic equipment, Packaging, Random vibration, Vibration tests, Fatigue life

An electronic packaging system comprised of hermetic chip carriers that were mounted on a large ceramic substrate which in turn was mounted on a printed wiring board was step-stressed at random vibration levels beginning at 4.8 grms. Failure occurred at the substrate leads after about 1½ minutes of vibration at 15 grms. Damping was added to the system by inserting a silicone rubber plug between the ceramic substrate and the printed wiring board. Again failure occurred at the leads after approximately 1 minute of testing at 19 grms. It was shown that the fatigue life of the leads could be predicted with reasonable accuracy by using simple analysis techniques.

82-1751
Wear of Connector Contacts Exposed to Relative Motion
R.A. Wilk
ITT DCD, Nutley, NJ, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 77-81, 4 figs, 1 table, 4 refs

Key Words: Electronic equipment, Connectors (electronic equipment), Contact vibration, Wear

Relative motion between mated connectors can lead to premature system failure due to contact wear. This motion can be generated from vibration encountered in handling, transportation, and service. An investigation of different style contacts (tuning fork, box, and circular) was performed to determine their endurance when exposed to relative motion. The effects of contact wear are described, and guidelines on connector selection and mounting are provided to minimize this wear and enhance system reliability.

82-1752
Analysis and Test of Ceramic Substrates for Packaging of Leadless Chip Carriers
A.E. Hatheway and C. Montano
Alson E. Hatheway Inc., Pasadena, CA, "Designing

Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 49-51, 4 figs, 1 table

Key Words: Electronic equipment, Equipment response, Random vibration, Gunfire effects, Fatigue life, Packaging

This paper reports on the analysis and test methods used to design the User Equipment Section of the Global Positioning System, Phase II at Magnavox Advanced Products & Systems Company. This effort follows a successful Phase I effort which demonstrated the capabilities of GPS to give precision locating information to portable ground receiver stations. The Phase II equipments were designed to be installed on nine different platforms for all three military services. Since the sets have a large number of common modules among them much of the equipment had to be designed to operate under a worst case combination of environments for all nine applications. The equipments had to survive random vibration in two different forms: a normal random power-spectral-density spectrum and a gun fire vibration composed of a random power-spectral-density superimposed on top of a sweeping sine wave vibration.

82-1753

Design Guides for Random Vibration

D.S. Steinberg

Litton Guidance and Control, Woodland Hills, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 13-15, 3 figs, 2 refs

Key Words: Random vibration, Electronic test equipment, Design techniques

The author describes possible random vibration environments for electronic packages and suggests several design approaches to control resonant peaks in order to control fatigue life.

82-1754

Design for Random - An Example

G.K. Hobbs

Tustin Inst. of Tech., Inc., Santa Barbara, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 17-18, 2 refs

Key Words: Random vibration, Aircraft equipment response, Equipment response, Design techniques

This paper reviews a case in which the manufacturer of an airborne power supply failed to account for the effects of random vibration. Changes made in order to pass qualification tests were readily accomplished once proper design principles were followed. The paper describes the faults uncovered and the solution to each.

82-1755

Design for Long Fatigue Life in Random Vibration Environment

J.M. Medaglia

General Electric Co., Philadelphia, PA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 25-35, 15 figs, 1 table, 20 refs

Key Words: Random vibration, Fatigue life, Spacecraft equipment response, Equipment response, Root mean cubes, Thomson-Baron formula, Design techniques

Design parameters regarding the environment, structural response, and allowable load data are discussed. Examples drawn from design of spacecraft and windmill equipment show that for fatigue, the root mean cube response is a useful single amplitude for design life regardless of the complexity of the life cycle load history. Another useful approach is the Thomson-Baron formula for the response of a single degree of freedom oscillator in a random amplitude environment. Numerical methods and more approximate methods are discussed.

82-1756

Guidelines for Random Vibration Design of Electronic Equipment

W.J. Vitaliano

Harris Corp., Melbourne, FL, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 19-24, 8 figs, 3 refs

Key Words: Random vibration, Electronic test equipment, Design techniques

This paper is a partial compilation of the author's 15 years' experience in design and analysis of military electronic equipment. Sample calculations are presented to give the analyst a simple method for assessing the effects of random vibration on electronic equipment. Examples are given demonstrating random vibration design considerations. Typical problem areas resulting from random vibration presented in this paper include hybrid leads, relays, crystal oscillators, and connectors. Guidelines are presented for adequate structural design.

82-1757

Designing Electronic Equipment for Random Vibration Environments

P.Y. Lee

TRW, Redondo Beach, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 43-47, 3 figs, 1 table, 2 refs

Key Words: Random vibration, Electronic test equipment, Design techniques, Spacecraft equipment

Random vibration environments on space vehicles are due to a multitude of different but significant loads -- acoustic, turbulent boundary layer, wake impingement, oscillating shocks, separated flows, etc. These loads appear on a vehicle at different places during different periods of its trajectory and their intensity and excitation characteristics depend on both trajectory and geometric parameters. For the design of electronic equipment mounted inside a vehicle, service acoustic loads are generally of the greatest concern. Random vibration design levels are established by collecting the response acoustic data on certain locations on the vehicle. The data are reduced in the form of power spectral densities (PSD). Since the internal panels, either honeycomb or reinforced sheet/plate structure, on which the equipments are mounted represent a large portion of the total area exposed to acoustics, vibration levels based on sound pressure would invariably be maximum in the direction normal to the panels. The levels of random vibration both normal and parallel to the mounting panel on a typical exploratory-type space vehicle are compared. It can be seen that at most frequencies the PSD is twice as high in one direction as in the others. The equipment design to be discussed in this paper is suitable for most but is best fitted for this type of random vibration equipment.

82-1758

Computer-Aided Interactive Structural Optimization of Printed-Circuit-Board Design

L.B. Duncan, R.E. Holman, B.K. Lagasse, L.W. Sakamoto, and W.H. Sunada

Thermal/Structural Mech. Dept., Hughes Aircraft Co., Culver City, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 53-57, 3 figs, 12 refs

Key Words: Optimization, Computer-aided techniques, Design techniques, Circuit boards, Electronic test equipment

A computer program has been developed which enables the average designer, functioning in an interactive mode at a terminal, to optimize the design of a printed-circuit board for specified dynamic environments. The program takes the designer, by a logical and iterative procedure, through the steps of load defintion, initial board configuration, boundary conditions and reinforcing provisions, to final board configuration. The goal of the program is to ensure the boards do not undergo excessive flexure during imposed vibratory loading, thereby preventing piece-part component lead fracture, which is the leading cause of circuit-board structural failure. The program utilizes well-proven, experimentally verified equations for the analysis.

82-1759

Random Vibration Effects on Piece Part Applications

H. Luhrs

TRW, Redondo Beach, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 59-64, 4 figs, 3 tables, 6 refs

Key Words: Circuit boards, Electronic test equipment, Random vibration

The aspects of designing for electronic piece parts in a random vibration environment is the subject of this paper. These are the deflection and inertial load requirements for typical printed circuit boards, the part attachment to the board, and the vibration specifications for the part itself. The analytically and empirically derived limits used were based upon typical spacecraft electronic equipment designs, and random vibration levels. Most of the electronic equipment is used for communications, data handling, and power. A typical random vibration specification spectrum is given.

82-1760

Design of Cathode Ray Tubes for Use in a Random Vibration Environment

W.R. McCauley and J. Spector

Lawrence Livermore Natl. Lab., Livermore, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 65-70, 6 figs

Key Words: Random vibration, Electronic test equipment, Design techniques

Design of a cathode ray tube for use in a random vibration environment is not a trivial task. The testing of the tube to a random vibration specification should be done with great care. Minute changes can occur within the tube which do not readily show up to the unaided eye but which alter the meaning and accuracy of the data displayed on the tube. The presence of these changes indicates that structures are moving relative to each other inside the tube. The result of changes of this type may be a premature failure of the cathode ray tube.

82-1761

Power Supplies Designed for Random Vibration

R.I. Dagle

Litton Guidance and Control Systems, Woodland Hills, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 71-76, 12 figs, 1 table, 2 refs

Key Words: Random vibration, Electronic test equipment, Design techniques

In the design of today's systems and subsystems, individual modules, circuit cards, and mounting chassis have to be tuned to avoid the amplification of resonant frequencies. The power supply, because of its weighty components, usually presents unique problems. After the power supply has been optimized to meet electrical, thermal, manufacturability, repairability requirements, a random vibration analysis sometimes sends the design back to the drawing board. Methods are pointed out to reduce this time consuming problem and to help the mechanical designer of power supplies to be able to recognize, early in the design process, faults or problems, and be able to resolve them.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 1741, 1742, 1743, 1780)

82-1762

Effectiveness of Predictive Computer Programs in the Design of Noise Barriers -- A Before and After Approach. Part II-A. Final Report

J.K. Haviland and D.F. Noble

Virginia Highway and Transportation Research Council, Charlottesville, VA, Rept. No. VHTRC-81-T54-PT-2A, FHWA/VA-81/55, 59 pp (June 1981)

PB82-139536

Key Words: Noise barriers, Traffic noise, Design techniques, Computer aided techniques

To evaluate the efficacy of the predictive computer programs used to design the barriers, noise measurements were taken before and after construction of an earth berm and plywood wall alongside a highway. The effect of the barrier was taken as the difference between the before and after dropoffs in noise levels from the roadside to the location under study. The measured effects were compared to the predicted effects. Less than half of the measured effects were within 3 dB of the predicted values. However, when the effects of the time of day and human activity within the neighborhood were taken into account, 65% of the noise values obtained during periods of low human activity were within 3 dB of the predicted values. Thus, it is thought that the computer program can be effectively used in designing noise barriers.

82-1763

Transient Waves Due to Randomly Moving Dislocation

A.I. Beltzer

Dept. of Aerospace and Mech. Engrg., College of Engrg., San Diego State Univ., San Diego, CA 92182, Intl. J. Engrg. Sci., 20 (7), pp 845-850 (1982) 2 figs, 16 refs

Key Words: Elastic waves, Wave propagation, Stochastic processes, Acoustic emission

Stochastic motion of a dislocation and the radiated field are considered in this paper. The derived equations relate the relationships between the parameters of radiation and those of a dislocation movement. The exact solution is given for the transient elastic waves of shot noise type due to a screw dislocation motion of finite duration.

SHOCK EXCITATION

82-1764

Statistical Characterization of Strong Ground Motions Using Power Spectral Density Function

S.-S.P. Lai
Dept. of Construction Engrg. and Tech., Natl. Taiwan Inst. of Tech., Taipei, Taiwan Bull. Seismol. Soc. Amer., 72 (1), pp 259-174 (Feb 1982) 11 figs, 1 table, 16 refs

Key Words: Power spectra, Spectral energy distribution techniques, Ground motion, Statistical analysis

The spectral content and duration of some 140 strong-motion accelerograms are studied with an aim of quantifying the uncertainty of ground motion representation. Ground motions are characterized by the parameters of the Kanai-Tajimi spectral density function and by the strong-motion duration. Parameters are estimated for each record based on the method of spectral moments. The statistics and dependencies of the parameters are evaluated, and in particular, correlations between the Kanai-Tajimi parameters, peak ground acceleration, epicentral distance, and local magnitude are investigated. The findings constitute the basis for characterizing seismic input for the purpose of safety assessment of constructed facilities.

82-1765
Fast-Acting Blast Doors Protect Nuclear Experiments
J.C. Weydert
Sandia Labs., Albuquerque, NM, Mach. Des., pp 83, 85 (Mar 25, 1982)

Key Words: Blast resistant structures, Doors

The design of a blast door, consisting of a pair of fast-acting blast gates that close a fraction of a second after a nuclear device has been detonated, is described.

82-1766
On a Dusty-Gas Shock Tube
H. Miura and I.I. Glass
Inst. for Aerospace Studies, Toronto Univ., Downsview, Ontario, Canada, Rept. No. UTIAS-250, CN-ISSN-0082-5255, 80 pp (May 1982)
N82-13151

Key Words: Shock tubes, Shock wave propagation

Analytical and numerical methods were used to investigate the flow induced by a shock wave in a shock-tube channel containing air laden with suspended small solid particles. Exact results are given for the frozen and equilibrium shock wave properties as a function of diaphragm-pressure ratio and shock-wave Mach numbers. The driver contained air at high pressure. A modified random-choice method together with an operator-splitting technique show the decay of a discontinuous frozen shock wave, a contact discontinuity, formation of a stationary shock structure, and an effective contact front of finite thickness. The effects of particle diameter, particle-number density, and diaphragm-pressure ratio on the transitional behavior of the flow are investigated in detail. The alteration of flow properties due to the presence of particles is discussed in detail and compared with classical shock-tube flows.

82-1767
Self-Refraction of Small Amplitude Shock Waves
V.E. Fridman
Radiophysical Res. Inst., Gorky, USSR, Wave Motion, 4 (2), pp 151-161 (Apr 1982) 6 figs, 1 table, 9 refs

Key Words: Shock waves, Small amplitudes, Wave refraction

A theory is developed for self-refraction of small amplitude shock waves, which includes the effects of a nonlocal nonlinearity. A complete system of self-refraction equations describing the two-dimensional motion of a shock-wave front is suggested. The system involves equations describing the amplitude variation at the front and the cross sectional area of a ray tube when a wave propagates along rays orthogonal to the front. Coupling equations are relations of nonlinear geometrical acoustics, defining the amplitude at the front through the ray tube cross section and the amplitude gradient along a ray. A particular form of the system of equations describing the self-refraction of triangular pulses is analyzed and automodel solutions are given.

VIBRATION EXCITATION
(Also see No. 1790)

82-1768
On the Investigations of the Particle Displacement by Means of High-Frequency Oscillations
V. Milukiene and K. Ragulskis
Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (36), pp 157-161 (1981) 5 figs, 5 refs
(In Russian)

Key Words: High frequency excitation, Interaction: structure-foundation, Coulomb friction, Viscous friction

The displacement of the particle with respect to a base in which high frequency standing waves are generated is studied. The interaction of the particle with the base is described with dry and viscous friction forces acting on the particle. The results of the working problem by means of the EDC are presented.

82-1769

Random Vibration of Vibromachine Elastic System

D. Gabadadze

Institut mechaniki mashin AN Gruzizkoi SSR, Vibrotechnika, 2 (36), pp 49-55 (1981) 5 refs

(In Russian)

Key Words: Vibrators (machinery), Random vibration

Random vibration of an elastic vibromachine with inertial and kinematic excitations is considered. During investigation random errors of rigidity and form of elastic system and of excitation source are taken into account. Non-stationary solution for probability density of amplitude and phase of random vibrations are obtained.

82-1770

Use of ˢcrew Translational Symmetry for the Vibration A.. .ysis of Structures

G.S. Whiston

C.E.R.L., Kelvin Ave., Leatherhead, Surrey, UK, Intl. J. Numer. Methods Engrg., 18 (3), pp 435-444 (Mar 1982) 4 figs, 2 tables, 2 refs

Key Words: Vibration analysis, Bodies of revolution, Screw translational symmetry

A method for the exploitation of screw translational symmetry for the vibration analysis of structures is presented. The method is capable of providing significant computational economies over the use of the lower axial translational symmetry of such structures.

82-1771

An Experimental Study of Dynamic Friction Processes at Concentrated Metallic Contacts During Sliding

C.-H. Kim

Ph.D. Thesis, State Univ. of New York at Buffalo, 173 pp (1981)

UM DA8204078

Key Words: Friction, Sliding friction, Metals

Dynamic normal and frictional forces, including inertia forces, have been measured at frequencies between 0 and 2 kHz during the nominally smooth sliding of metal surfaces. A number of previously unrecognized characteristics of frictional mechanics have been discovered and quantified. It is shown that large audio-frequency normal and frictional force fluctuations are present, long before significant loss of contact or other obvious changes in average frictional force behavior begin to occur. These fluctuations are shown to be largely caused by normal vibratory excitation associated with the interactions of surface irregularities on the sliding surfaces and are therefore inherent in the sliding process itself. During this kind of dynamic loading the instantaneous coefficient of friction does not remain constant but varies about the average kinetic coefficient of friction in synchronism with the contact force fluctuations.

82-1772

Dynamics of Vibropercussive System with Oblique Impacts. I

V. Veteris, B. Kučinskas, V. Ragulskienė, and V. Sabatauskienė

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (31), pp 71-78 (1981) 7 figs, 1 ref

(In Russian)

Key Words: Periodic response, Natural frequencies

The results of dynamics research of the system with oblique impact are given in the article. Steady-state natural vibrations, their domains of existence, and their characteristics are investigated.

82-1773

Improved Potential Gradient Method to Calculate Airloads on Oscillating Supersonic Interfering Surfaces

M.H.L. Hounjet

Natl. Aerospace Lab., NLR, Amsterdam, The Netherlands, J. Aircraft, 19 (5), pp 390-399 (May 1982) 7 figs, 6 tables, 16 refs

Key Words: Aerodynamic loads, Aircraft wings, Gradient methods

A description is given of a computationally improved potential gradient method to calculate unsteady aerodynamic derivatives in supersonic flow. Results are presented and comparisons are made with results of existing methods and with experimental data for a fighter-type wing.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 1583, 1618, 1833)

82-1774

Iterative Determination of Squeeze Film Damper Eccentricity for Flexible Rotor Systems

L.M. Greenhill and H.D. Nelson

Garrett Turbine Engine Co., Phoenix, AZ, J. Mech. Des., Trans. ASME, 104 (2), pp 334-338 (Apr 1982) 11 figs, 2 tables, 9 refs

Key Words: Dampers, Squeeze-film dampers, Bearings, Rotor-bearing systems, Unbalanced mass response

A method is presented to determine the eccentricity of multiple squeeze film dampers used in multishaft rotor bearing unbalance response analyses. The procedure is iterative and is based upon the secant root finding algorithm. Unbalance response is calculated using the iteratively determined eccentricity in closed form expressions of squeeze film stiffness and damping coefficients, for either long or short bearing theory. Circular centered synchronous operation is assumed. The method is demonstrated by determining the response of a single mass centrally preloaded rotor, a multimass flexible rotor supported by two squeeze films, and a multishaft flexible rotor system employing three squeeze film supports. The results obtained in the flexible rotor analysis are compared to test data, with the correlation found to be good. Due to rapid convergence and multiple squeeze film capability, the procedure is particularly suited to large multishaft flexible rotor-bearing system analysis.

82-1775

A Phenomenological Theory of Hysteresis Damping of Vibrations in Ferromagnetic Materials

S. Motogi

Osaka Municipal Technical Res. Inst., Ohgimachi 2-1-1, Kitaku Osaka, Japan, Intl. J. Engrg. Sci., 20 (7), pp 823-834 (1982) 4 figs, 9 refs

Key Words: Hysteretic damping, Magnetoelasticity, Metals, Torsional vibration

The hysteresis damping of vibrations in magnetostrictive polycrystalline ferromagnetic materials is investigated theoretically. The constitutive relation for applied moment and twisted angle in torsion is derived directly from the stress-strain constitutive relation. Precise damping characteristics of torsional vibrations of ferromagnetic wires are obtained in small amplitudes and in large amplitudes after the saturation of magnetostriction.

82-1776

Substitute Dynamic Model of System with Viscoelastic Element (Náhradní dynamický model systému s viskoelastickým prvkem)

F. Pochyly

Research Inst. SIGMA, Olomouc, Czechoslovakia, Strojnicky Časopis, 33 (1), pp 71-33 (1982) 2 figs, 6 refs

(In Czech)

Key Words: Viscoelastic damping, Stiffness coefficients, Damping coefficients, Mathematical models

On the basis of the constitutional relations presented, the differential equation of the system is derived by means of the methods of continuum mechanics. The coefficients of the equation express properties of the viscoelastic element, which represents stiffness and damping of mass M. The conditions are mentioned under which the stiffness and damping can be identified by means of the skeleton curves and limit envelopes. The mathematical model of the substitute dynamic model with one degree of freedom contains convolution integrals by means of which the results can be proved and generalized.

82-1777

An Improved Forced-Vibration Technique for Measurement of Material Damping

R.F. Gibson, A.Yau, and D.A. Riegner

Engrg. Sci. Dept. and Mech. Engrg. Dept., Univ. of Idaho, Exptl. Techniques, 6 (2), pp 10-14 (Apr 1982) 3 figs, 1 table, 13 refs

Key Words: Material damping, Composite materials, Measurement techniques

Recent investigations of the effects of environmental conditions on the vibration characteristics of automotive composite materials have led to the extensive modification of an existing forced-vibration technique. Resonant response of the specimen is now measured by using noncontacting eddy-current probes instead of strain gages, and the method of clamping the specimen has been improved. Excitation-response data is then obtained in digital form rather than by photographing Lissajous patterns. The errors introduced by new and old techniques and representative data for E-glass/polyester automotive composite materials are discussed.

82-1778

Ferrofluid Inertia Dampers Enhance Stepper Motor Performance

J. Schaufeld

Ferrofluidics Corp., Nashua, NH, Des. News, pp 58-60, 62 (Apr 5, 1982)

Key Words: Viscous damping, Motors

Viscous inertia damping of stepper motors using ferrofluids, colloidal suspensions of subdomain-size magnetic particles in a liquid carrier, is described.

82-1779

The Spine of the Root Locus for the Viscous Damper

D. Stern

Appl. Sci. Lab., Space Div., General Electric Co., Philadelphia, PA 19101, J. Mech. Des., Trans. ASME, 104 (2), pp 466-475 (Apr 1982) 19 figs, 1 table, 13 refs

Key Words: Vibration isolators, Viscous damping, Optimization, Damping coefficients

At present the optimization of a vibration isolator is performed in either the time domain or the frequency domain. A new approach, for optimization in the S-plane, is outlined and performed for the viscous damper. Optimization of the viscous damper in the S-plane results in a line that is defined as the spine of the root locus. Transformations are required between the S-plane and either the frequency domain or the time domain; therefore, time and frequency response plots are included for the spine damper. Two examples are used to illustrate the application of the root locus for single mass and multi-mass models.

FATIGUE

(Also see Nos. 1689, 1714, 1750, 1752, 1755)

82-1780

Acoustic Measurements of F100-PW-100 Engine Operating in Hush House NSN 4920-02-070-2721

V.R. Miller, G.A. Plzak, and J.M. Chinn

Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH, Rept. No. AFWAL-TM-81-133-FIBE, 58 pp (Sept 1981)

AD-A108 814

Key Words: Acoustic fatigue, Engine noise

The purpose of this test program was to measure the acoustic environment in the hush house facility located at Kelly AFB Texas during operation of the F100-PW-100 engine to ensure that engine structural acoustic design limits were not exceeded. The acoustic measurements showed that no sonic fatigue problems are anticipated with the F100-PW-100 engine structure during operation in the hush house. The measured acoustic levels were less than those measured in an existing F100-PW-100 engine wet-cooled noise suppressor, but were increased over that measured during operation on an open test stand. It was recommended that the acoustic load increases measured in this program should be specified in the structural design criteria for engines which will be subjected to hush house operation or defining requirements for associated equipment.

82-1781

Vibration-Fatigue Reliability Analysis

H.B. Chenoweth

Westinghouse Electric Corp., Baltimore, MD, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 37-42, 2 figs, 17 refs

Key Words: Fatigue life, Reliability, Spacecraft

The Birnbaum-Saunders model of mechanical fatigue failure is utilized to formulate a general vibration fatigue reliability prediction model. This model determines the hazard rate for a combined catastrophic and fatigue failure mode for a narrow band structure with varying material properties. An example is provided for a typical aerospace structure.

82-1782

Effect of Gas Pores from Shop-Primed Plate Material on the Fatigue Strength of Longitudinal Fillet Welds

R. Olivier and W. Ritter
Lab. f. Betriebsfestigkeit, Fraunhofer-Gesellschaft z. Foerderung der angewandten Forschung e.V., Darmstadt, Fed. Rep. Germany, Rept. No. LBF-FB-160, 49 pp (1981)
N82-15469
(In German)

Key Words: Welded joints, Fatigue life

Welding of shop-primed plate-materials usually leads to the formation of porosity defects by arising gas bubbles penetrating through the weld metal. These gas pores especially occur in fillet welds and may even reach the weld surface. The effect of gas pores of different size and density on the fatigue strength of fillet welds loaded in the longitudinal direction was examined. In contrast to fillet welds lying transversely to the loading direction, the portion of areas of gas pores or clustered pores to the whole load-carrying cross section remains largely irrelevant for fillet welds lying in the loading direction. The parameters in welding and finishing techniques are included under statistical aspects thus allowing generalized conclusions to be drawn on the fatigue behavior of longitudinal fillet welds with gas pores.

82-1783
Influence of Throat and Plate Thickness on the Fatigue Strength of Fillet Welds
E. Haibach, R. Olivier, and W. Ritter
Lab. f. Betriebsfestigkeit, Fraunhofer-Gesellschaft zur Foerderung der angewandten Forschung e.V., Darmstadt, Fed. Rep. Germany, Rept. No. LBF-FB-131, 69 pp (1981)
N82-15457
(In German)

Key Words: Welded joints, Fatigue strength, Statistical analysis

An investigation was carried out aiming at the influence of throat and plate thickness on fatigue strength of fillet welds with fatigue critical toe. The statistical test program refers to angular fillet welds made from steel MRSt 37-2 and includes twelve fabrication variants. The fillets were welded in the horizontal or flat position under a mixed gas atmosphere by means of the M.A.G. welding process: in the case of 10 mm plate thickness as single pass with 4 mm throat thickness and with case of 50 mm plate thickness as flat faced fillets by multiple pass with 20 mm or 35 mm throat thickness. At all considered variants, the fatigue strength decreased with increasing plate and throat thickness.

82-1784
Fatigue Test Methodology
Advisory Group for Aerospace Res. and Dev., Neuilly-sur-Seine, France, Rept. No. AGARD-LS-118, 253 pp (Oct 1981)
AD-A107 561

Key Words: Fatigue tests, Testing techniques

The following topics are discussed: the role of fatigue testing; planning and analyzing a fatigue testing program; fatigue test machines; variable amplitude fatigue testing; on-line computers in fatigue testing; fatigue testing of fiber composites; elevated temperature fatigue testing of metals; fatigue tests with a corrosive environment; methods of obtaining crack growth data in metals; monitoring of damage in fiber composites; and cyclic strain approach to fatigue in metals.

ELASTICITY AND PLASTICITY

82-1785
The Investigation of the Elastic Fulcrum with the Circular Elastic Elements
A. Kelzon, A. Zobnin, and A. Kuzmin
Leningradskoe visshee inzheneroe morskoe uchilishche im. S.O. Makarova, Vibrotechnika, 2 (36), pp 57-73 (1981) 6 figs, 7 refs
(In Russian)

Key Words: Fulcrum, Elastic properties, Damping

An algorithm for the calculation of damping and strength of an elastic fulcrum with a smooth bore elastic element is developed. It is shown that the bearing under consideration has nonlinear elastic characteristics. Recommendations for the application of fulcrum are given.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

82-1786
Development of Procedures for Nondestructive Testing of Concrete Structures. Report 3. Feasibility of

Impact Technique for Making Resonant Frequency Measurements
A.M. Alexander
Army Engineer Waterways Experiment Station, Vicksburg, MS, Rept. No. WES-MP-C-77-11-3, 36 pp (Nov 1981)
AD-A109 814

Key Words: Concretes, Nondestructive tests, Resonant frequencies, Modal analysis

Development of the resonant frequency technique as a method for evaluation of concrete structures is in progress. It is desirable that structures be evaluated in place, nondestructively, and in real time. The availability of digital Fourier analyzers and mathematical functions such as spectra, coherence, and transfer relationships permits the analysis of the behavior of large structures under dynamic conditions in place and in real time. An impact system has been tested which was proven more economical and versatile than the sinusoidal system currently in use.

82-1787
An Improved Ground Vibration Test Method. Volume 1. Research Report
D.W. Gimmestad, R.F. Michalak, D.L. Brown, R.J. Allemang, and C.S. Doherty
Boeing Military Airplane Co., Seattle, WA, Rept. No. AFWAL-TR-80-3056-VOL-1, 492 pp (Sept 1980)
AD-A108 262

Key Words: Aircraft, Vibration tests, Testing techniques

Research was conducted to develop an improved method for ground vibration testing of airplanes. The resulting method, a single point excitation-frequency response analysis method, utilizes the computer, modern electronic equipment, developments in vibration testing theory and improvements in mechanical system design to accomplish ground vibration tests at greatly reduced cost while significantly improving accuracy. A demonstration ground vibration test was conducted using the improved method on an A-10 airplane.

82-1788
Response Spectrum Analysis for Random Vibration
K. Foster
Foster Engrg. Co., Woodland Hills, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 9-11

Key Words: Random vibration, Vibration response spectra, Vibration tests

The author describes the development and application of response spectrum. As a practical matter, the peak values are sometimes more significant. In random vibration testing, the peak value is usually assumed to correspond to the three sigma value; i.e., equal to three times the RMS value.

82-1789
Random Vibration Basics for Electronics Packaging Design
W. Tustin
Tustin Inst. of Tech., Inc., Santa Barbara, CA, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 7-8, 10 refs

Key Words: Random vibration, Vibration tests, Screening, Testing techniques

This paper briefly discusses the differences between testing and screening, discusses shaker system limitations and briefly mentions the fixtures which are used to attach test articles to shakers.

82-1790
Speaking in a Random Fashion
G.M. Hieber
Hieber Engrg., Watchung, NJ, "Designing Electronic Equipment for Random Vibration Environments," Proc. of the Meeting of the Institute of Environmental Sciences, Mar 25-26, 1982, Los Angeles, CA, pp 1-6, 8 figs

Key Words: Vibration tests, Random vibration, Standard deviation, Power spectral density

The theory, meaning and method of obtaining standard deviation and spectral density parameters of a random signal is explained.

82-1791

Ice Phobics Blade Tracking and Comparison of Vibration Analysis Techniques

W.Y. Abbott, F.L. Dominick, and S. Arthur
Army Aviation Engrg. Flight Activity, Edwards AFB, CA, Rept. No. USAAEFA-79-86, 64 pp (May 1981)
AD-A108 121

Key Words: Vibration measurement, Measuring instruments, Helicopters, Propeller blades, Blades, Coatings

An evaluation of two vibration measuring devices, the Chadwick-Helmuth VIBREX and the Scientific-Atlanta Vibration Signature Recorder, as flight test instrumentation was conducted. During the course of these evaluations, it was determined that the Dow Corning E2460-40-1 (redesignated E2978-46) ice phobic coating applied to the rotor blades of a UH-1H helicopter, did not induce undesirable vibrations. It was also concluded that the VIBREX may be used as test instrumentation if the frequencies of interest are already known, and the Scientific-Atlanta device provides good quick look spectral vibration data.

82-1792

Deconvolution of Time Domain Waveforms in the Presence of Noise

N.S. Nahman and M.E. Guillaume
Natl. Bureau of Standards, Washington, DC, Rept. No. NBS-TN-1047, 125 pp (Oct 1981)
PB82-135153

Key Words: Frequency domain method, Time domain methods, Fast Fourier transform, Frequency filters

Deconvolution or inverse filtering was used to determine the impulse response of a system using noisy input and output time domain sequences (discrete data). Frequency and time domain methods were studied along with the synthesis of the filters required to obtain stable and smooth results. For the methods studied it was concluded that the superior technique was provided by an optimal frequency domain method implemented via the FFT. Also, it is pointed out that the time domain methods are only in their infancy and still retain the promise of avoiding transform domain filtering. Examples are presented in which the impulse responses are determined in the presence of varying degrees of noise for a coaxial transmission line, a wave-shaping filter, and a broadband antenna.

82-1793

Improved Methods for the Fast Fourier Transform (FFT) Calculation of the Frequency Response Function

L.D. Mitchell
Dept. of Mech. Engrg., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, J. Mech. Des., Trans. ASME, 104 (2), pp 277-279 (Apr 1982) 3 figs, 1 table, 4 refs

Key Words: Frequency response function, Fast Fourier transform

Most FFT machines today compute an estimate of the frequency response function, H(f), by the cross-spectral density of input to output divided by the power spectral density of the input. This estimator is contaminated by noise at the input. One uses the coherence function to help measure the level of contamination. However, the coherence function detects, among other things, noise at both the input and output. Several alternate methods are proposed for the computation of the frequency response function. One generates more accurate estimates at resonance, one has half or less of the contamination contained in the present methods, and the last one proposes to eliminate the biasing contamination altogether.

82-1794

An Investigation of Accuracy of Photoelectric Measuring Converter by the Means of Injectic Optical Diode Based on GA AS

R. Kairiūnas and C. Kaušinis
Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (36), pp 151-155 (1981) 4 figs, 2 refs
(In Russian)

Key Words: Vibration measurement, Measuring techniques, Photographic techniques

Photoelectric measuring converter incorporating a series of photo diodes is investigated. The application of a single optical diode as a light radiation source in the device is considered.

82-1795

On the Resultant Influence of Different Distorting Factors on the Accuracy Operation of the Position Measuring Transformer

P. Čaplikas, S. Kaušinis, and K. Ragulskis
Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (36), pp 99-111 (1981) 7 figs, 5 refs
(In Russian)

Key Words: Transformers, Geometric effects, Error analysis

Electrical, geometrical and physical errors of transformers were investigated. The effect of geometrical parameters of the transformer on the error of analytical results is presented.

82-1796

Harmonic Excitation of Vibrators Used for Electrospark Alloying

I. Dobinda, A. Paramonov, A. Semenchuk, and S. Fursov

Institut prikladnoi fiziki AN MSSR, Vibrotechnika, 2 (36), pp 15-23 (1981) 6 figs, 8 refs

(In Russian)

Key Words: Vibrators (machinery), Harmonic excitation

The boundaries of the stability zone of the first order subharmonic for impact vibrator mechanism with harmonic excitation are determined when there is no energy dissipation at friction $\beta = 0$, unilateral limitation $\lambda \geqslant 0$ and absolutely inelastic impact as the main aggregate values of its vibration.

DYNAMIC TESTS

(Also see No. 1786)

82-1797

Utility of a Probability-Density-Function Curve and F-Maps in Composite-Material Inspection

J.L. Rose, Y.H. Heong, and M.J. Avioli

Drexel Univ., Philadelphia, PA 19104, Exptl. Mech., 22 (4), pp 155-160 (Apr 1982) 6 figs, 3 refs

Key Words: Nondestructive tests, Probability density function, Composite materials

The use of probability-density-function analysis, an important topic in statistical analysis, is studied in this paper with respect to its utility in nondestructive testing. In addition to the mathematical concepts, several sample problems in composite-material inspection are presented. A feature map is introduced as a new procedure that gives us a new way to examine composite materials. An inspectability parameter based on feature probability-density-function analysis is introduced for a composite-material fabrication process that makes damage detection more reliable.

82-1798

Mechanical Shock Test Analysis. Final Report

W.E. Layman

Bendix Corp., Kansas City, MO, Rept. No. BDX-613-2678, 13 pp (Sept 1981)

DE82000932

Key Words: Shock tests, Testing instrumentation, Hammers

A hammer impact form of mechanical shock testing was investigated for use on a high voltage electrical assembly. The hammer was attached so that it could fall freely through a specified angle of elevation. Data from the Bendix Kansas City tests correlated with data from similar tests at Sandia National Laboratory, Albuquerque.

DIAGNOSTICS

82-1799

Preventive Maintenance Keeps Compressor Engines at Peak Efficiency

J.O. King and N. Goodman

Texas Gas Transmission Corp., Owensboro, KY, Oil Gas J., 80 (15), pp 111-114 (Apr 12, 1982) 4 figs

Key Words: Diagnostic instrumentation, Testing instrumentation, Compressors, Reciprocating engines

Modern testing and diagnostic equipment for reciprocating engines and gas turbines at Texas Gas Transmission Corp. is described.

82-1800

One Dimensional Diagnosing System Model of Gear Drive

A. Golovinov

Vibrotechnika, 2 (36), pp 25-30 (1981) 4 figs, 1 ref

(In Russian)

Key Words: Diagnostic techniques, Gear drives

The paper deals with the model of multifactor effect of interference on effective signal and shows the way of transition to the model of one dimensional system of gear drive diagnosis. For this purpose a test diagnosing, instead of a functional one, is used in reversing regime with a small angular rate. It solves the problem of identification of signals from gear drive pairs and determines their technical state according to side play that was chosen as a structural parameter.

82-1801

Acoustic Emission - Fundamental Aspects

A. Nielsen

Svejsecentralen, Glostrup, Denmark, Rept. No. ISBN-87-87806-48-7, 80-02, 18 pp (1980)

PB82-155870

Key Words: Diagnostic techniques, Acoustic emission, Steel

At the present state it has to be envisaged that a straight forward application of an available acoustic emission equipment to find significant defects in any present steel structure is not recommendable and may be disappointing. Utmost care, experience from using the particular equipment, control of sensitivities and knowledge of the mechanical, metallurgical and acoustic emission properties of the materials in question are necessary in order to clarify what information on the state and integrity of a structure may reliably be derived from application of acoustic emission techniques. In many cases a clever exploitation of particular properties or conditions or ways of conducting the testing and acoustic emission of structures may lead to a successful provision of information to be of help within plant condition monitoring.

82-1802

Techniques of Identifying Sources of Noise and Vibration

R.S. Rothschild

Rothschild and Associates, Greenwich, CT, Des. News, pp 51-54, 56 (Apr 5, 1982) 5 figs

Key Words: Diagnostic instrumentation, Noise source identification, Real time spectrum analyzers

The article describes the operation of single and dual channel real time analyzers and their application in solving machinery noise and vibration problems.

82-1803

Effect of Inter-Modulation and Quasi-Periodic Instability in the Diagnosis of Rolling Element Incipient Defect

C.C. Osuagwu and D.W. Thomas

Dept. of Electronic and Electrical Engrg., Univ. of Nigeria, Nsukka, Anambra State, Nigeria, J. Mech. Des., Trans. ASME, 104 (2), pp 296-302 (Apr 1982) 9 figs, 2 tables, 10 refs

Key Words: Diagnostic techniques, Rolling contact bearings, Incipient failure detection

The absence of significant peaks at the fundamental rotational frequencies, indicative of a particular defect such as an outer race fault, results in a failure of the power spectrum technique to detect and diagnose mechanical defects characterized by sounds of short duration. Based on the results of an incipient defect diagnosis, explanations are offered as to the cause of the missing fundamental in the power spectrum in terms of two different effects which may operate simultaneously. The paper also shows that fault detection and diagnosis are possible despite the absence of a significant peak at the fundamental rotational frequency.

82-1804

Use of Cepstra in Acoustical Signal Analysis

R.H. Lyon and A. Ordubadi

Dept. of Mech. Engrg., Massachusetts Inst. of Tech., Cambridge, MA 02139, J. Mech. Des., Trans. ASME, 104 (2), pp 303-306 (Apr 1982) 7 figs, 5 refs

Key Words: Cepstrum analysis, Acoustic signatures, Signal processing techniques

Cepstral analysis is an example of nonlinear filtering that has been applied to extracting the properties of transmission path and source characteristics in acoustics. A review is made of some of the properties of linear windowing in the time and frequency domains with a view to revealing the limitations that these methods have. The cepstrum and the conditions under which it can be helpful in separating source and path characteristics are described. The method is illustrated by describing some applications. Research directions that may help to extend the applicability of cepstral analysis to structural vibration transmission are also discussed.

82-1805

A Mathematical Basis for the Random Decrement Vibration Signature Analysis Technique

J.K. Vandiver, A.B. Dunwoody, R.B. Campbell, and M.F. Cook

Massachusetts Inst. of Tech., Cambridge, MA 02139, J. Mech. Des., Trans. ASME, 104 (2), pp 307-313 (Apr 1982) 4 figs, 11 refs

Key Words: Random decrement technique, Vibration signatures, Signal processing techniques

The mathematical basis for the random decrement technique of vibration signature analysis is established. The general relationship between the auto-correlation function of a random process and the Randomdec signature is derived. For the particular case of a linear time invariant system excited by a zero-mean, stationary, Gaussian random process, a Randomdec signature of the output is shown to be proportional to the auto-correlation of the output. Example Randomdec signatures are computed from acceleration response time histories from an offshore platform.

82-1806

Dynamic Photoelasticity as an Aid in Developing New Ultrasonic-Test Methods

C.P. Burger, A. Testa, and A. Singh
Dept. of Engrg. Sci. and Mech. and Engrg. Res. Inst., Iowa State Univ., Ames, IA 50011, Exptl. Mech., 22 (4), pp 147-154 (Apr 1982) 15 figs, 1 table, 15 refs

Key Words: Photoelastic analysis, Ultrasonic techniques, Failure detection, Discontinuity-containing media

A prerequisite for the development of quantitative ultrasonic-inspection techniques for surface flaws is a thorough understanding of the ways in which elastic waves interact with defects. Analytical and numerical approaches are presently inadequate. Experimental methods are needed for a better understanding of wave interactions with real geometries. This paper describes how dynamic photoelasticity was used to study the interaction between Rayleigh waves and slots.

BALANCING

(Also see Nos. 1595, 1677)

82-1807

Turbomachine Balance Correction System

R.P. Tameo
Dept. of the Navy, Washington, DC, U.S. Patent-4 294 135, 4 pp (Oct 13, 1981)

Key Words: Balancing machines, Turbomachinery, Rings

A balance system for rotating turbomachinery and other rotating devices is provided wherein balance correction is obtained by snap rings having both an intentional eccentricity of their center of mass and discrete peripheral features which are adapted to be received in corresponding recesses in the machinery.

82-1808

Automatic Balancing System with Laser Unit

A. Giers
Carl Schenck, A.G., Darmstadt, Fed. Rep. Germany, Rept. No. BMFT-FB-T-81-008, ISSN-0340-7608, 28 pp (Jan 1981)
N82-14502
(In German)

Key Words: Balancing machines, Lasers, Gyroscopes

A balancing plant for miniature rotor gyroscopes was developed, using a pulsed laser for material removal in order to perform the necessary measurements and balancing processes in one single operation. The plant, consisting of five units, is depicted and illustrated by graphs and photographs. The tests were intended to check the machine, to get experimental data, and to investigate the possibilities of this technology. As compared to conventional procedures, this automatic balancing process with laser compensation is rationalized, is faster, is cheaper, and provides a higher balancing quality. The test results confirm the system reliability as well as the process advantages.

82-1809

Complete Shaking Force and Shaking Moment Balancing of Link Mechanisms Using Balancing Idler Loops

C. Bagci
Dept. of Mech. Engrg., Tennessee Technological Univ., Cookeville, TN 38501, J. Mech. Des., Trans. ASME, 104 (2), pp 482-493 (Apr 1982) 10 figs, 22 refs

Key Words: Balancing techniques, Mechanisms

A method for completely balancing the shaking forces and shaking moments in mechanisms is presented. The method introduces shaking moment balancing idler parallelogram loop (or loops) which transfers the motion of a coupler link to a shaft on the frame of the mechanism, where the rotary balancers balance the shaking moment. The complete balancing of a mechanism is accomplished by maintaining the total center of mass of the mechanism stationary meanwhile achieving that the total angular momentum of the moving links of the mechanism vanishes. Positioning of the idler loops is illustrated for a series of multiloop mechanisms. Theorems on the complete balancing of shaking forces and shaking moments in the mechanisms are established. Design equations for completely balancing some single and multiloop mechanisms are given. A numerical example is included.

82-1810

Application of the Principle of Reciprocity to Flexible Rotor Balancing

M.S. Darlow and A.J. Smalley

Mechanical Technology Inc., Latham, NY, J. Mech. Des., Trans. ASME, 104 (2), pp 329-333 (Apr 1982) 4 figs, 4 tables, 7 refs

Key Words: Balancing techniques, Rotors, Flexible rotors, Reciprocity principle, Influence coefficient method, Unified balancing approach

This paper begins with a theoretical discussion of the principle of reciprocity and its application to flexible rotor balancing. The particular means by which reciprocity can be applied to improve the influence coefficient and Unified Balancing Approach procedures are then described in detail. A numerical study was conducted to verify this application of reciprocity, as well as to investigate any possible limitations. The results of this study are reported along with those of a similar experimental study using two substantially different test rotors.

82-1811

Experiments on the Dynamic Behavior of a Supercritical Rotor

M. Botman and M.A. Samaha

Pratt & Whitney Aircraft of Canada, Ltd., Longueuil, Quebec, Canada, J. Mech. Des., Trans. ASME, 104 (2), pp 364-369 (Apr 1982) 12 figs, 3 tables, 12 refs

Key Words: Rotors, Balancing techniques

Tests have been performed on supercritical rotors to determine the sensitivity to unbalance and the suitability of balancing techniques. Results are presented for a rotor with an overhanging disk and supported on two rolling element bearings in series with squeeze-film dampers. The rotor has two flexural modes with high relative strain energy in the speed range up to 55,000 rpm. After completion of the balancing exercise the rotor could be run to maximum speed and was found to be stable and free from half-frequency whirl instability, depending on the oil inlet pressure of the dampers.

MONITORING

(Also see No. 1806)

82-1812

Bearing Fault Detection Using Adaptive Noise Cancelling

G.K. Chaturvedi and D.W. Thomas

Dept. of Electronics, Univ. of Southampton, Southampton, S09 5NH, UK, J. Mech. Des., Trans. ASME, 104 (2), pp 280-289 (Apr 1982) 16 figs, 3 tables, 15 refs

Key Words: Monitoring techniques, Statistical analysis, Spectrum analysis

The ability to diagnose a mechanical fault is enhanced if the monitoring signal can be preprocessed to reduce the effect of unwanted noise. To this end, the adaptive noise cancelling technique (ANC) can substantially improve the signal to noise ratio where the required signal is contaminated by noise. ANC makes use of two inputs – a primary input which contains the corrupted signal, and a reference input containing noise correlated in some unknown way with the primary noise. A variation of ANC is also proposed and it is shown that this can be applied effectively in those situations where inputs contain correlated signals but uncorrelated or weakly correlated noises. Using vibrational data derived from a reasonably complex bearing rig and preprocessing the data by the ANC technique, this paper shows that the statistical and spectral analysis techniques can be made more effective in their diagnostic roles after the application of ANC.

82-1813

A New Method of Modeling Gear Faults

R.B. Randall

Bruel & Kjaer, Naerum, Denmark, J. Mech. Des., Trans. ASME, 104 (2), pp 259-267 (Apr 1982) 15 figs, 13 refs

Key Words: Monitoring techniques, Gears, Spectrum analysis, Signal processing techniques, Cepstrum analysis

Detailed mathematical models of gear vibrations have appeared in recent years, but to utilize them requires a detailed knowledge of the gearbox components and their dynamic properties. This paper presents an alternative approach which is applicable to the monitoring and diagnosis of gearbox faults based on an analysis of changes in the vibration signal, showing how these can be related back to various classes of fault. Most emphasis is placed on the effects of the various types of faults on the spectrum, but the applicability of two other techniques, synchronous signal averaging and cepstrum analysis, is also discussed comparatively, making use of practical examples.

82-1814

Signature Analysis Applied to Drilling

S. Braun, E. Lenz, and C.L. Wu

Israel Inst. of Tech., Haifa, Israel, J. Mech. Des., Trans. ASME, 104 (2), pp 268-276 (Apr 1982) 13 figs, 16 refs

Key Words: Monitoring techniques, Drills, Signal processing technique

This paper investigates the relationship between drill life, the sound, and the drift forces produced by the drilling process. Tests were performed while drilling steel with 38 in. twist drills. As a tool life criterion, the wear of the drill lips was monitored. Typical signals are described, and various signal processing techniques presented in view of characterizing them. These include time, frequency, and amplitude domain techniques. It is shown that specific signal patterns that occur with increasing lip wear show definite trends which can be followed by some analysis techniques. A discrete point process, derived from the signal's spectrum, has been found specifically valuable.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

(Also see Nos. 1686, 1733)

82-1815

Structural Dynamics: Modified Calculations

G. Hornung and H. Roehrle

Dornier-Werke GmbH, Friedrichshafen, Fed. Rep. Germany, Rept. No. BMVG-FBWT-81-1, 83 pp (1981)

N82-13457

(In German)

Key Words: Natural frequencies, Harmonic response, Aircraft, Aircraft wings

Calculation methods which give natural and harmonically excited vibrations of modified structures, using the results of the original systems, are presented and tested. Most of the methods are based on a linear approximation; i.e., the individual terms of the equations of motion are subdivided into those of the original system and into corresponding difference terms whose products are subsequently neglected. Tests are carried out for simple models as well as for three-dimensionally idealized wing and aircraft structures.

82-1816

Generalized Coordinate Partitioning in Dynamic Analysis of Mechanical Systems

R.A. Wehage, E.J. Haug, and R.R. Beck

College of Engrg., Univ. of Iowa, Iowa City, IA, Rept. No. U-OF-IOWA-75, TACOM-TR-12590, 197 pp (June 16, 1981)

AD-A108 683

Key Words: Numerical analysis, Dynamic response

A computer-based method for formulation and efficient solution of nonlinear, constrained differential equations of motion is developed for planar mechanical systems. Nonlinear holonomic constraint equations and differential equations of motion are written in terms of a maximal set of Cartesian generalized coordinates, to facilitate the general formulation of constraints and forcing functions.

82-1817

Stability Analysis of an Extrapolated Force Correction Method for Nonlinear Structural Dynamics

D.M. Trujillo

TRUCOMP, Fountain Valley, CA 92708, J. Appl. Mech., Trans. ASME, 49 (1), pp 203-205 (Mar 1982) 4 figs, 6 refs

Key Words: Force correction method, Stability, Nonlinear theories

Conditions for the unconditional stability of an extrapolated force correction method have been identified. The analysis assumed a nonlinear elastodynamic system for which energy is conserved. Some numerical examples are included to demonstrate the performance of the method.

82-1818

Mechanical Impedance of Ice, Asphalt Concrete and "Ice-Asphalt Concrete" Systems. I

V. Veteris, B. Kučinskas, K.-R. Petrauskas, and V. Ragulskienė

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (31), pp 85-87 (1981) 2 figs, 3 refs

(In Russian)

Key Words: Mechanical impedance, Ice, Concretes

The article presents results of the experimental research on definition of the impedance characteristics of ice, asphalt concrete and ice-asphalt concrete system. The influence of thickness and temperature of the investigated samples on size of impedance and its phase angle is defined.

82-1819

Mechanical Impedance of Ice, Asphalt Concrete and "Ice-Asphalt Concrete" System

V. Veteris, B. Kučinskas, K.-R. Petrauskas, and V. Ragulskiene

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (32), pp 29-31 (1981) 1 table, 2 refs

(In Russian)

Key Words: Mathematical models, Mechanical impedance, Ice, Concretes

A rheological model and its parameters suitable for ice, concrete and ice-asphalt concrete are given.

82-1820

Estimations of the Periodical Solutions of the Linear Differential Equations with Random Parameters

V. Rubanik

Gomelskii gosuniversitet, USSR, Vibrotechnika, 1 (31), pp 7-11 (1981) 2 refs

(In Russian)

Key Words: Random vibration

Pure and imaginary roots of characteristic equations in the determination of periodic solutions of linear differential equations with random parameters are considered. The solution is obtained by statistical regularization method using Byes formula and Byes estimation.

82-1821

Dynamics of Vibropercussive System with Glancing Collisions. 2

V. Veteris, B. Kučinskas, V. Ragulskiene, and V. Sabatauskiene

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (32), pp 17-28 (1981) 9 figs, 2 refs

(In Russian)

Key Words: Vibration analysis

The results of research in the dynamics of systems with glancing collisions are presented. Transient states and periodical regimes of the forced percussive oscillations were studied and parameters of movement, existence and stability regions were defined.

82-1822

Systematic Generation of Nonlinear Discretized Dynamic Equilibrium Equations of Spinning Cantilevers

M. El-Essawi, S. Utku, and M. Salama

Civil Engrg. Dept., Duke Univ., Durham, NC 27706, Computers Struc., 15 (3), pp 259-282 (1982) 6 figs, 11 tables, 4 refs

Key Words: Cantilever beams, Rotating structures, Rayleigh-Ritz method, Finite element technique, Computer programs

The Rayleigh-Ritz procedure, in conjunction with any admissible trial solution in terms of undetermined functions of time and known yet unspecified coordinate functions of space, is systematized to obtain the coefficient matrices of the second order nonlinear ordinary differential equations of dynamic equilibrium of a spinning cantilever with initial geometric imperfections. In the functional second order nonlinear strain-displacement and velocity-displacement relationships are used, and the material is assumed linearly elastic. Systematic forms for the discretized energy density expressions are provided. A computer program for the systematic generation of the coefficient matrices involved in the governing equations is described.

82-1823

Design Sensitivity Analysis and Optimization of Constrained Dynamic Systems

N.C. Barman, E.H. Haug, and R.R. Beck

College of Engrg., Univ. of Iowa, Iowa City, IA, Rept. No. U-OF-IOWA-56, TACOM-TR-12587, 180 pp (June 16, 1981)

AD-A108 684

Key Words: Dynamic systems, Design techniques, Sensitivity analysis, Optimization, Computer programs

The technical objective of this report is the derivation of a systematic and unified theory and organization of a corresponding general computer program for the design of constrained dynamic systems by judicious selection of the most suitable methods from the following branches of mathematics and mechanics: optimization methods, rigid body mechanics, numerical integration methods, and matrix manipulation methods. Accordingly, a method of formulating and automatically integrating the equations of motion and design sensitivity adjoint equations for general constrained dynamic systems is presented.

82-1824

Dynamic Analysis and Design of Constrained Mechanical Systems

E.J. Haug, R.A. Wehage, R.R. Beck, and N.C. Barman
College of Engrg., Univ. of Iowa, Iowa City, IA, Rept. No. U-OF-IOWA-50, TACOM-TR-12588, 57 pp (June 12, 1981)
AD-A108 685

Key Words: Dynamic systems, Design techniques, Sensitivity analysis, Optimization, Computer programs

A method for formulating and automatically integrating the equations of motion of quite general constrained dynamic systems is presented. Design sensitivity analysis is also carried out using a state space method that has been used extensively in structural design optimization. Both dynamic analysis and design sensitivity analysis and optimization are shown to be well-suited to application of efficient sparse matrix computational methods. Numerical integration is carried out using a stiff numerical integration method that treats mixed systems of differential and algebraic equations. A computer code that implements the method of planar systems is outlined and a numerical example is treated. The dynamic response of a classical slider-crank is analyzed and its design is optimized.

MODELING TECHNIQUES

(Also see No. 1634)

82-1825

Application of a Parameter Identification Method to Driving Systems of Roller Rotary Presses (Zur Anwendung einer Parameteridentifikationsmethode auf Antriebssysteme von Rollenrotationsmaschinen)

R. Taubald
Maschinenbautechnik, 31 (3), pp 113-115 (1982) 1 fig, 3 tables, 4 refs
(In German)

Key Words: Mathematical models, Parameter identification technique, Stiffness coefficients, Natural frequencies, Mode shapes

The development of a mathematical model for the determination of natural frequencies and mode shapes of a branched system is presented. The model is first set up using statically measured torsional stiffness coefficients. The natural frequencies obtained by this model are considerably above the measured natural frequencies and the sequence of mode shapes differs from that of the actual machine. The model is modified by varying the stiffness coefficients until model finally obtained is tested by calculating natural frequencies and mode shapes of a rotary press. Sufficiently accurate results were obtained.

PARAMETER IDENTIFICATION

(Also see Nos. 1659, 1825)

82-1826

System Identification of Large-Scale Structures

M.W. Dobbs, K.D. Blakely, and W.E. Gundy
ANCO Engineers, Inc., Santa Monica, CA, SAE Paper No. 811050

Key Words: Parameter identification technique, System identification techniques, Offshore structures, Drilling platforms, Dams, Computer programs

An efficient algorithm for system identification of large-scale structures is presented. The efficiency and practicality of the algorithm is demonstrated by application to models of an offshore steel-template platform and a concrete dam. The majority of the computational effort for system identification is required for structural parameter estimation. This computational effort is minimized by including closed form analytical response derivatives for sensitivity calculations and parameter linking for problem size reduction. These features and a general purpose finite element code developed to include these features are discussed.

82-1827

Structural System Identification Technology Verification

N. Giansante, A. Berman, W.G. Flannelly, and E.J. Nagy
Kaman Aerospace Corp., Bloomfield, CT, Rept. No. USAAVRADC-TR-81-D-28, 218 pp (Nov 1981)
AD-A109 181

Key Words: System identification technique, Mathematical models, Helicopters

Structural system identification is the method of obtaining structural and dynamic mathematical models and improving existing mathematical models using ground vibration test data. The purpose of the subject program was to perform experimental, development, and research work to verify the concepts of structural system identification technology. The results of the program indicate that system identification is a viable and cost-effective technique for developing new models and for improving existing finite-element models of an airframe using ground vibration test data.

82-1828

Identification of Multi-Input Multi-Output Linear Systems from Frequency Response Data

P.L. Lin and Y.C. Wu

Dept. of Control Engrg., Natl. Chiao Tung Univ., Taiwan, Rep. of China, J. Dyn. Syst., Meas. and Control, Trans. ASME, 104 (1), pp 58-64 (Mar 1982) 1 fig, 26 refs

Key Words: System identification technique, Frequency response, Least-squares method

A procedure for identifying a multi-input multi-ouput linear system from frequency response data is developed. Individual transfer functions from individual input to individual output are identified via the generalized least-squares theory. Orders of the transfer functions are determined by testing the residual. The minimal order multi-input multi-output system is identified based on the formation of a composite system comprising the subsystems associated with all individual outputs followed by decomposition. This is actually the problem of minimal realization involving inexact system parameters.

OPTIMIZATION TECHNIQUES

(Also see Nos. 1758, 1823, 1824)

82-1829

Dynamic Matrix Control of Imbalanced Systems

C.R. Cutler

Shell Oil Co., ISA Trans., 21 (1), pp 1-6 (1982) 6 figs, 2 refs

Key Words: Dynamic matrix control, Optimum control theory

Dynamic matrix control (DMC) provides the control engineer with a powerful new tool for the control of processes when process control computers are available. DMC is an optimal controller that can handle multivariable interactive control problems for systems that can be described or approximated by a set of linear differential equations. The method provides a continuous projection of a system's future outputs for the time horizon required for the system to come to steady state. The optimality of the controller is based upon finding the set of time-dependent changes for the manipulated input that minimize the error from the set point of the projected outputs over the time horizon. DMC permits the solution of control problems for systems with unusual dynamic behavior. The objectives of this paper are to present the concepts of the DMC method and then to display the concepts of a level control problem, illustrative of an imbalanced system.

DESIGN TECHNIQUES

(See Nos. 1686, 1753, 1755, 1756, 1757, 1760, 1761, 1823, 1824)

COMPUTER PROGRAMS

(Also see Nos. 1635, 1716)

82-1830

SHORE IV: Finite Element Program for Dynamic and Static Analysis of Shells of Revolution (Theoretical Manual)

O.M. El-Shafee, P.K. Basu, B.J. Lee, and P.L. Gould

Dept. of Civil Engrg., Washington Univ., St. Louis, MO, Rept. No. NSF/CEE-81057, 108 pp (Oct 1981) PB82-147919

Key Words: Computer programs, Finite element technique, Shells of revolution, Shells, Plates, Interaction: soil-structure

The theoretical background of the software (SHORE-IV) for the static and dynamic analysis of axisymmetric shells and plates is provided. In the SHORE-IV program, the shell is discretized by high precision rotational shell finite elements of any quadratic shape. The thickness of the element may vary in the meridional direction. To consider the effect of regularly spaced members at the base or at some intermediate level of the shell, special open type elements are used. The shell may be orthotropic (single or multi layer), isotropic, or framed. The program can handle both axisymmetric and asymmetric external effects such as mechanical and thermal loads, horizontal and vertical base accelerations, and support settlements.

82-1831
SHORE IV: Finite Element Program for Dynamic and Static Analysis of Shells of Revolution (User's Manual)
O.M. El-Shafee, P.K. Basu, B.J. Lee, and P.L. Gould
Dept. of Civil Engrg., Washington Univ., St. Louis, MO, Rept. No. NSF/CEE-81056, 124 pp (Oct 1981)
PB82-147927

Key Words: Computer programs, Finite element technique, Shells of revolution, Shells, Plates, Interaction: soil-structure

The SHORE-IV computer program is designed for the linear static and dynamic analysis of arbitrarily loaded thin to moderately thick elastic shells of revolution. Axisymmetric shells founded on footing foundations may be analyzed dynamically including the soil structure interaction effect. This user manual describes the procedure to be followed in preparing the input data for this program. Cards for problem identification, problem control, element, nodal point, material information, displacement function, output requirement, control data, soil, and loading information are described. A number of sample inputs and outputs utilizing the various options of the program are included.

82-1832
The Underwater Shock Analysis Code (USA-Version 3): A Reference Manual
J.A. DeRuntz, T.L. Geers, and C.A. Felippa
Lockheed Missiles and Space Co., Inc., Palo Alto, CA, Rept. No. LMSC-D777843, DNA-5615F, 197 pp (Sept 15, 1980)
AD-A108 773

Key Words: Computer programs, Underwater sound, Shock waves, Submerged structures, Underwater structures, Transient response

This report constitutes a reference manual for the third version of the Underwater Shock Analysis (USA) Code, a computer program for calculation of the transient response of a totally or partially submerged structure to a spherical shock wave of arbitrary pressure profile and source location. The code considers the structure to be linear-elastic and treats the surrounding fluid as an infinite acoustic medium.

82-1833
Finite Element Vibration Analysis of Damped Structures
M.L. Soni and F.K. Bogner
Univ. of Dayton Res. Inst., Dayton, OH, AIAA J., 20 (5), pp 700-707 (May 1982) 15 figs, 4 tables, 19 refs

Key Words: Computer programs, Finite element technique, Damped structures, Natural frequencies, Mode shapes, Amplitude analysis, Phase data, Modal damping

A finite element computer program, MAGNA-D, has been developed for predicting the response of damped structures to steady-state inputs. The use of a unique finite element library and efficient programming techniques make the procedure especially applicable to sizable three-dimensional structures composed of both solid and shell-like components. The program predicts frequencies and mode shapes, steady-state amplitudes and phase angles, and modal damping factors. The analysis includes the damping effects of viscoelastic materials characterized by complex moduli, and of Coulomb friction at sliding interfaces. Examples are presented to illustrate the utility and efficiency of the computer program.

82-1834
Rotorcraft Flight Simulation Computer Program C81 with DATAMAP Interface, Volume II. Programmer's Manual
P.Y. Hsieh
Bell Helicopter Textron, Ft. Worth, TX, Rept. No. BHT-699-099-111-VOL-2, USAAVRADCOM-TR-80-D-38B, 264 pp (Oct 1981)
AD-A108 294

Key Words: Computer programs, Helicopters, Propeller blades, Mode shapes

This report documents the current version in the C81 family of rotorcraft flight simulation programs developed by Bell Helicopter Textron. This current version of the digital computer program is referred to as AGAP80. The accompanying program for calculating fully coupled rotor blade mode shapes is called DNAM05, and an associated rotor wake program is called AR9102. The AGAP80 version of C81 was developed by adding some analytical features to the AGAJ76 version and including the ability to generate Data Transfer Files for use by the File Creation Program of DATAMAP. Volume II includes a catalog of subroutines and a discussion of programming considerations.

82-1835
Rotorcraft Flight Simulation Computer Program C81 with DATAMAP Interface. Volume I. User's Manual
J.R. Van Gaasbeek

Bell Helicopter Textron, Fort Worth, TX, Rept. No. BHT-699-099-111-VOL-1, USAAVRADCOM-TR-80-D-38A
AD-A108 246

Key Words: Computer programs, Helicopters, Propeller blades, Mode shapes

This report documents the current version in the C81 family of rotorcraft flight simulation programs developed by Bell Helicopter Textron. This current version of the digital computer program is referred to as AGAP80. The accompanying program for calculating fully-coupled rotor blade mode shapes is called DNAM05, and an associated rotor wake program is called AR9102. The AGAP80 version of C81 was developed by adding some analytical features to the AGAJ76 version, and including the ability to generate Data Transfer Files for use by the File Creation Program of DATAMAP. The User's Manual contains the detailed information necessary for setting up an input data deck and interpreting the computed data.

82-1836
Computer Code EURDYN - 1 M (Release 1) for Transient Dynamic Fluid-Structure Interaction. Pt 1: Governing Equations and Finite Element Modelling
J. Donea, P. Fasoli-Stella, S. Giuliani, J.P. Halleux, and A.V. Jones
Joint Res. Ctr., Commission of the European Communities, Ispra, Italy, 90 pp (1980)
EUR-6751

Key Words: Computer programs, Finite element technique, Interaction: structure-fluid, Nuclear reactor components, Containment structures

This report describes the governing equations and the finite element modelling used in the computer code EURDYN - 1 M. The code is a nonlinear transient dynamic program for the analysis of coupled fluid-structure systems. It is designed for safety studies on LMFBR components (primary containment and fuel subassemblies).

GENERAL TOPICS

CONFERENCE PROCEEDINGS

82-1837
Vibration in Power Plant Piping and Equipment
Joint Conf. of the Pressure Vessels and Piping, Materials, Nuclear Engrg., Solar Energy Divisions of the ASME, R.C. Jotti, ed., ASME, 1981, 59 pp $14.00
Bk. No. H00192

Key Words: Power plants (facilities), Piping systems, Proceedings

The objective of this symposium is to provide a forum for the exchange of information and to contribute to the state-of-the-art of the design against and the assessment of vibrations. Subjects treated include experimental and analytical data supporting correlations important in design, sophisticated design methods for piping and support systems, methodology for design against accidental transients, and testing programs to evaluate the effect of vibrations. Individual papers are abstracted in the appropriate sections of the Digest.

82-1838
Fluid/Structure Interactions in Turbomachinery
Winter Annual Meeting of the ASME, Washington, DC, Nov 15-20, 1981, W.E. Thomson, ed., ASME, 1981, 78 pp
Bk. No. H00202

Key Words: Interaction: structure-fluid, Turbomachinery, Proceedings

At this symposium the interaction of fluid and structural dynamic characteristics of turbomachinery were discussed. Particularly stressed were feedback mechanisms by which such vibrations become self-excited, the nonlinear character of the damping if not the structure, stability criteria for nonlinear systems, and the nature of the fluid dynamic excitation. Individual papers are abstracted in the appropriate sections of this issue.

CRITERIA, STANDARDS, AND SPECIFICATIONS
(Also see No. 1840)

82-1839
Handbook for Measuring Interstate Rail Carrier Noise Emissions
Office of Noise Abatement and Control, Environmental Protection Agency, Washington, DC, Rept. No. EPA-550/9-81/200, 100 pp (Jan 1981)
PB82-145335

Key Words: Railroad cars, Noise measurement, Standards and codes

The purpose of this handbook is to provide guidance in measuring compliance with the source noise emission standards. The handbook is directed at compliance officers, railroad personnel, local residents, and other concerned individuals interested in assessing whether or not the noise emissions from a particular rail yard facility exceed the regulatory levels.

BIBLIOGRAPHIES

82-1840

Seismic Design for Buildings and Building Codes. 1970 - Feb. 1982 (Citations from the Engineering Index Data Base)

NTIS, 305 pp (Feb 1982)

PB82-863382

Key Words: Bibliographies, Seismic design, Standards and codes, Buildings, Foundations

This bibliography covers seismic design considerations and building codes for various types of non-nuclear structures, chiefly buildings and their foundations. Design criteria for earthquake protection are considered in general terms and with respect to specific types of structures. Cases of actual damage assessments for earthquake resistant and non-resistant structures are also included.

82-1841

Earthquake Engineering: Buildings, Bridges, Dams, and Related Structures. September, 1980-1981 (Citations from the NTIS Data Base)

NTIS, 186 pp (Feb 1982)

PB82-804170

Key Words: Bibliographies, Buildings, Bridges, Dams, Nuclear power plants, Seismic analysis

Seismic phenomena relative to buildings, bridges, dams, and other structures are investigated. Damage assessment is made and design inadequacies are revealed. Suggestions for structural improvements for dynamic response are presented. Abstracts on site selection and earthquake-proofing for atomic power plants are included.

82-1842

Earthquake Engineering: Buildings, Bridges, Dams, and Related Structures. September, 1979 - Aug. 1980 (Citations from the NTIS Data Base)

NTIS, 195 pp (Feb 1982)

PB82-804162

Key Words: Bibliographies, Buildings, Bridges, Dams, Nuclear power plants, Seismic analysis

Seismic phenomena relative to buildings, bridges, dams, and other structures are investigated. Damage assessment is made and design inadequacies are revealed. Suggestions for structural improvements for dynamic response are presented. Abstracts on site selection and earthquake-proofing for atomic power plants are included.

82-1843

Gear Design and Testing. 1972 - January, 1982 (Citations from the International Aerospace Abstracts Data Base)

NTIS Rept. for 1972 - Jan 1982, 152 pp (Jan 1982)

PB82-860495

Key Words: Bibliographies, Gears, Design techniques, Testing techniques

The bibliography contains abstracts of reports relevant to the design and testing of a wide variety of gears and gear assemblies. The analysis of gearing and gearbox design is featured. Wear life and vibration control are also discussed. Methods for testing gear materials for wear resistance and structural stability are included. Gearing design of power transmissions for turbine and helicopter engines is included.

82-1844

Gear Design and Testing. 1970 - January, 1982 (Citations from the NTIS Data Base)

NTIS Rept. for 1970 - Jan 1982, 239 pp (Jan 1982)

PB82-860503

Key Words: Bibliographies, Gears, Design techniques, Testing techniques

The bibliography contains abstracts of reports relevant to the design and testing of a wide variety of gears and gear assemblies. Topics include the effect of design criteria on gear wear and fatigue, lubricants, inspection procedures, methods of manufacture and material selection. Emphasis is placed on helicopter and turbine engines.

AUTHOR INDEX

TECHNICAL NOTES

R.J. Alfredson
First and Second Derivatives of Internal Combustion Engine Cylinder Pressure Diagrams
J. Sound Vib., 80 (2), pp 287-291 (Jan 22, 1982)
4 figs, 3 refs

S.M. Dickinson and E.K.H. Li
On the Use of Simply Supported Plate Functions in the Rayleigh-Ritz Method Applied to the Flexural Vibration of Rectangular Plates
J. Sound Vib., 80 (2), pp 292-297 (Jan 22, 1982)
11 refs, 3 tables

R. Perrin, T. Charnley, and T. Banu
Increasing the Lifetime of Warble-Suppressed Bells
J. Sound Vib., 80 (2), pp 298-303 (Jan 22, 1982)
3 figs, 9 refs

N.G. Stephen
The Second Frequency Spectrum of Timoshenko Beams
J. Sound Vib., 80 (4), pp 578-582 (Feb 22, 1982)
1 fig, 1 table, 7 refs

A.D. Garrad and P.W. Carpenter
On the Aerodynamic Forces Involved in Aeroelastic Instability of Two-Dimensional Panels in Uniform Incompressible Flow
J. Sound Vib., 80 (3), pp 437-439 (Feb 8, 1982)
1 fig, 6 refs

M. Sathyamoorthy and G.J. Efstathiades
Natural Frequencies of Rectangular Plates
J. Sound Vib., 80 (3), pp 440-443 (Feb 8, 1982)
1 table, 2 refs

J.B. Grotberg and E.L. Reiss
A Subsonic Flutter Anomaly
J. Sound Vib., 80 (3), pp 444-446 (Feb 8, 1982)
2 figs, 4 refs

J.R. Coleby and J. Mazumdar
Vibrations of Simply Supported Shallow Shells on Elliptical Bases
J. Appl. Mech., Trans. ASME, 49 (1), pp 227-229 (Mar 1982) 2 tables, 5 refs

H. Wada
Boundary Condition Effect on Forced Torsional Vibrations of a Cylindrical Rod Connected to an Elastic Half Space
J. Appl. Mech., Trans. ASME, 49 (1), pp 238-240 (Mar 1982) 2 figs, 3 refs

C.D. Turner
Wing/Control Surface Flutter Analysis Using Experimentally Corrected Aerodynamics
J. Aircraft, 19 (4), pp 342-344 (Apr 1982) 3 figs, 11 refs

F.C. Lockwood and N.G. Shah
New Method for the Computation of Probability Density Functions in Turbulent Flows
AIAA J., 20 (6), pp 860-862 (June 1982) 2 figs, 6 refs

CALENDAR

SEPTEMBER 1982

12-14 **Petroleum Workshop and Conference** [ASME] Philadelphia, PA *(ASME Hqs.)*

12-15 **1982 Design Automation Conference** [ASME] Washington, DC *(Prof. Kenneth M. Ragsdell, Purdue Univ., School of Mech. Engrg., West Lafayette, IN 47907 - (317) 494-8607)*

13-16 **International Off-Highway Meeting & Exposition** [SAE] Milwaukee, WI *(SAE Hqs.)*

OCTOBER 1982

4-6 **Convergence '82** [SAE] Dearborn, MI *(SAE Hqs.)*

4-6 **Lubrication Conference** [ASME] Washington, DC *(ASME Hqs.)*

4-7 **Symposium on Advances and Trends in Structural and Solid Mechanics** [George Washington University and NASA Langley Res. Ctr.] Washington, DC *(Prof. Ahmed K. Noor, Mail Stop 246, GWU-NASA Langley Res. Ctr., Hampton, VA 23665 - (804) 827-2897)*

5-7 **Western Design Engineering Show** [ASME] Anaheim, CA *(ASME Hqs.)*

12-15 **Stapp Car Crash Conference** [SAE] Ann Arbor, MI *(SAE Hqs.)*

17-21 **Power Generation Conference** [ASME] Denver, CO *(ASME Hqs.)*

25-28 **Advances in Dynamic Analysis and Testing** [SAE Technical Committee G-5] 1982 SAE Aerospace Congress & Exposition, Anaheim, CA *(Roy W. Mustain, Rockwell Space Systems Group, Mail St. AB97, 12214 Lakewood Blvd., Downey, CA 90421)*

25-28 **1982 SAE Aerospace Congress and Exposition** [SAE] Anaheim, CA *(SAE Hqs.)*

26-28 **53rd Shock and Vibration Symposium** [Shock and Vibration Information Center, Washington, DC] Danvers, MA *(Henry C. Pusey, Director, SVIC, Naval Res. Lab., Code 5804, Washington, DC 20375)*

NOVEMBER 1982

8-10 **Intl. Modal Analysis Conference** [Union College] Orlando, FL *(Prof. Raymond Eisenstadt, Union College, Graduate and Continuing Studies, Wells House, 1 Union Ave., Schenectady, NY 12308 - (518) 370-6288)*

8-12 **Acoustical Society of America, Fall Meeting** [ASA] Orlando, FL *(ASA Hqs.)*

8-12 **Truck Meeting & Exposition** [SAE] Indianapolis, IN *(SAE Hqs.)*

14-19 **American Society of Mechanical Engineers, Winter Annual Meeting** [ASME] Phoenix, AZ *(ASME Hqs.)*

DECEMBER 1982

14-16 **11th Turbomachinery Symposium** [Texas A&M University] Houston, TX *(Peter E. Jenkins, Turbomachinery Labs., Dept. of Mech. Engrg., Texas A&M Univ., College Station, TX 77843 - (713) 845-7417)*

FEBRUARY 1983

28-Mar 4 **SAE Congress & Exposition** [SAE] Detroit, MI *(SAE Hqs.)*

MARCH 1983

21-23 **NOISE-CON 83** [Institute of Noise Control Engineering] Cambridge, MA *(NOISE-CON 83, Massachusetts Inst. of Tech., Inst. Information Services, 77 Massachusetts Ave., Cambridge, MA 02139 - (617) 253-1703)*

28-31 **Design Engineering Conference and Show** [ASME] Chicago, IL *(ASME Hqs.)*

APRIL 1983

18-20 **Materials Conference** [ASME] Albany, NY *(ASME Hqs.)*

18-21 **Institute of Environmental Sciences' 29th Annual Technical Meeting** [IES] Los Angeles, CA *(IES, 940 E. Northwest Highway, Mount Prospect, IL 60056 - (312) 255-1561)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS:	American Federation of Information Processing Societies 210 Summit Ave., Montvale, NJ 07645
AGMA:	American Gear Manufacturers Association 1330 Mass Ave., N.W. Washington, D.C.
AHS:	American Helicopter Society 1325 18 St. N.W. Washington, D.C. 20036
AIAA:	American Institute of Aeronautics and Astronautics, 1290 Sixth Ave. New York, NY 10019
AIChE:	American Institute of Chemical Engineers 345 E. 47th St. New York, NY 10017
AREA:	American Railway Engineering Association 59 E. Van Buren St. Chicago, IL 60605
ARPA:	Advanced Research Projects Agency
ASA:	Acoustical Society of America 335 E. 45th St. New York, NY 10017
ASCE:	American Society of Civil Engineers 345 E. 45th St. New York, NY 10017
ASME:	American Society of Mechanical Engineers 345 E. 45th St. New York, NY 10017
ASNT:	American Society for Nondestructive Testing 914 Chicago Ave. Evanston, IL 60202
ASQC:	American Society for Quality Control 161 W. Wisconsin Ave. Milwaukee, WI 53203
ASTM:	American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103
CCCAM:	Chairman, c/o Dept. ME, Univ. Toronto, Toronto 5, Ontario, Canada
ICF:	International Congress on Fracture Tohoku Univ. Sendai, Japan
IEEE:	Institute of Electrical and Electronics Engineers 345 E. 47th St. New York, NY 10017
IES:	Institute of Environmental Sciences 940 E. Northwest Highway Mt. Prospect, IL 60056
IFToMM:	International Federation for Theory of Machines and Mechanisms U.S. Council for TMM c/o Univ. Mass., Dept. ME Amherst, MA 01002
INCE:	Institute of Noise Control Engineering P.O. Box 3206, Arlington Branch Poughkeepsie, NY 12603
ISA:	Instrument Society of America 400 Stanwix St. Pittsburgh, PA 15222
ONR:	Office of Naval Research Code 40084, Dept. Navy Arlington, VA 22217
SAE:	Society of Automotive Engineers 400 Commonwealth Drive Warrendale, PA 15096
SEE:	Society of Environmental Engineers 6 Conduit St. London W1R 9TG, UK
SESA:	Society for Experimental Stress Analysis 21 Bridge Sq. Westport, CT 06880
SNAME:	Society of Naval Architects and Marine Engineers 74 Trinity Pl. New York, NY 10006
SPE:	Society of Petroleum Engineers 6200 N. Central Expressway Dallas, TX 75206
SVIC:	Shock and Vibration Information Center Naval Research Lab., Code 5804 Washington, D.C. 20375
URSI-USNC:	International Union of Radio Science - U.S. National Committee c/o MIT Lincoln Lab. Lexington, MA 02173

*U.S. GOVERNMENT PRINTING OFFICE: 1982-0-361-334/546

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Unsolicited articles are accepted for publication in the Shock and Vibration Digest. Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress important recent technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

Manuscripts must be typed (double-spaced) and figures attached. It is strongly recommended that line figures be rendered in ink or heavy pencil and neatly labeled. Photographs must be unscreened glossy black and white prints. The format for references shown in DIGEST articles is to be followed.

Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the example below.

> Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and the practical applications that have been explored [3-7] indicate that . . .

The format and style for the list of References at the end of the article are as follows:

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- last name of author/editor followed by initials or first name
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- abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)
- volume, number or issue, and pages for journals; publisher for books
- year of publication in parentheses

A sample reference list is given below.

1. Platzer, M.F., "Transonic Blade Flutter - A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).

2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addision-Wesley (1955).

3. Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Devel. (1962).

4. Lin, C.C., Reissner, E., and Tsien, H., "On Two-Dimensional Nonsteady Motion of a Slender Body in a Compressible Fluid," J. Math. Phys., 27 (3), pp 220-231 (1948).

5. Landahl, M., Unsteady Transonic Flow, Pergamon Press (1961).

6. Miles, J.W., "The Compressible Flow Past an Oscillating Airfoil in a Wind Tunnel," J. Aeronaut. Sci., 23 (7), pp 671-678 (1956).

7. Lane, F., "Supersonic Flow Past an Oscillating Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24 (1), pp 65-66 (1957).

Articles for the DIGEST will be reviewed for technical content and edited for style and format. Before an article is submitted, the topic area should be cleared with the editors of the DIGEST. Literature review topics are assigned on a first come basis. Topics should be narrow and well-defined. Articles should be 1500 to 2500 words in length. For additional information on topics and editorial policies, please contact:

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Research Editor
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101 W. 55th Street, Suite 206
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Volume 14, No. 8 August 1982

EDITORIAL

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